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OBSERVATIONS ON THE NATURAL HISTORY OF THE FRESNO KANGAROO RAT

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The kangaroo rats of the San Joaquin Valley, California, have been objects of a study by mammalogists for many years. Only relatively recently, however, have any contributions been made on the natural history of these interesting rodents. Grinnell (1932) studied the habitat relations of the giant kangaroo rat (*Dipodomys ingens*). Shaw (1934) also worked on the same species, particularly on its methods of harvesting and storing seeds, and Hawbecker (1944) on its relation to sheep forage. The natural history of the Tulare kangaroo rat (*Dipodomys heermanni tularensis*) was studied by Tappe (1941). The present study was made on the Fresno kangaroo rat (*Dipodomys nitratoides exilis*) and supplements the knowledge on the other species inhabiting this area. The Fresno kangaroo rat, the smallest of the California kangaroo rats, was formerly thought to be extinct (Grinnell, 1922), but was rediscovered by the author (1934) about 15 miles west of its type locality (about four miles northwest of the center of the city of Fresno).

The immediate area of the type locality of *D. n. exilis* is under intensive cultivation and irrigation. The nearest point where specimens have been taken in recent years is about 13 miles to the west, the intervening land being under cultivation. The present known range extends to Fresno Slough, 30 miles to the west, then follows a line running in a general southeasterly direction to 26 miles southeast of Fresno. During the last several years many additional acres occupied by *D. n. exilis* have been cultivated and subjected to irrigation. Extensive irrigation with the development of the Central Valley Project will further decrease the favorable habitat of this subspecies, even to the possible extent of eliminating it entirely.

The area inhabited by this kangaroo rat is entirely on the flat valley floor, 185 to 300 feet above sea level. In no place where trapping has been done are there any hills, the only irregularities consisting of slight rolling places and slight humps and depressions. It is thought that the type specimen and first topotypes were taken near Fresno on a sand dune. Over most of the area, however, there are no such dunes. The slight mounds, in some places, may have some wind-blown soil, but the difference in elevation of these places above the rest of the

area is scarcely more than three feet. Many places where the animal is abundant the terrane is as nearly flat as one could expect to find. The region has an annual rainfall of less than 9 inches, falling mainly between November and February.

The more concentrated work of the present study was confined to two areas west and southwest of Fresno. The first area, Station 1, is located 5 miles west of the town of Kerman, or 20 miles west of Fresno (Pl. 1, upper). The second area, Station 2, is 10 miles southwest of Fresno (Pl. 1, lower).

Station 1.—Considerable trapping and excavating has been done at this station over a number of years. There are two types of terrane. Over most of the area there are elevations and depressions of up to 6 feet. During rainy season the depressions are temporary ponds, some of which are of considerable extent. Because of lack of drainage the soil is heavily alkaline, especially in the low places where the surface bakes hard in the summer. No burrowing animals occupy these depressions, obviously because of the water and perhaps also due to the hardness of the soil. The soil of the elevated portions is alkaline also, but it is light and often the surface is a powdery dust. The only vegetation is on the slightly elevated humps and consists mainly of grasses and alkali blite (*Suaeda moquini*). This soil is easily dug and is occupied by the kangaroo rats.

The other type of terrane consists of flat, irregular strips running through the humpy part in a general north and south direction. The elevation of the strips is about even with the tops of the humps of the irregular terrane. The soil is better drained and less alkaline. The surface is hard in summer but is fairly easy to dig. Vegetation is much more abundant, with scattered clumps of saltbush (*Atriplex*). Winter rains bring about a heavy growth of grasses and winter annuals. Pepper-grass (*Lepidium nitidum*), shepherd's purse (*Capsella bursa-pastoris*), and filaree (*Erodium*) are abundant. Kangaroo rats, pocket gophers, and ground squirrels burrow in this part of the terrane.

Station 2.—The terrane at station 2 is much more even than at station 1. The difference between the high and low places is only about two feet. There is no developed drainage so the water accumulates as small ponds during rainy season. Alkali patches are extensive with grass patches mainly on the elevations. There are grass- and forb-covered areas of some extent where the water does not remain long enough to kill the vegetation. The kangaroo rat burrow systems are on the elevations, entrance holes often being located so the excavated dirt is thrown onto the alkali. A burrow system will sometimes occupy one entire grass patch six to ten feet across. In summertime the first six to eight inches of the surface soil is hard. Beneath this layer the soil is loose and easily dug. The amount of dirt excavated by this species is very small, so that, even over a long period of time, there will be no mound of any size formed. It is thought that most of the dirt is blown away to accumulate in the grass of the slight elevations. In this area are scattered clumps of saltbush (*Atriplex*) and iodine bush (*Allenrolfea occidentalis*). Fresno kangaroo rats do not burrow under these scattered plants but where the stands are heavier the animals do burrow beneath them.

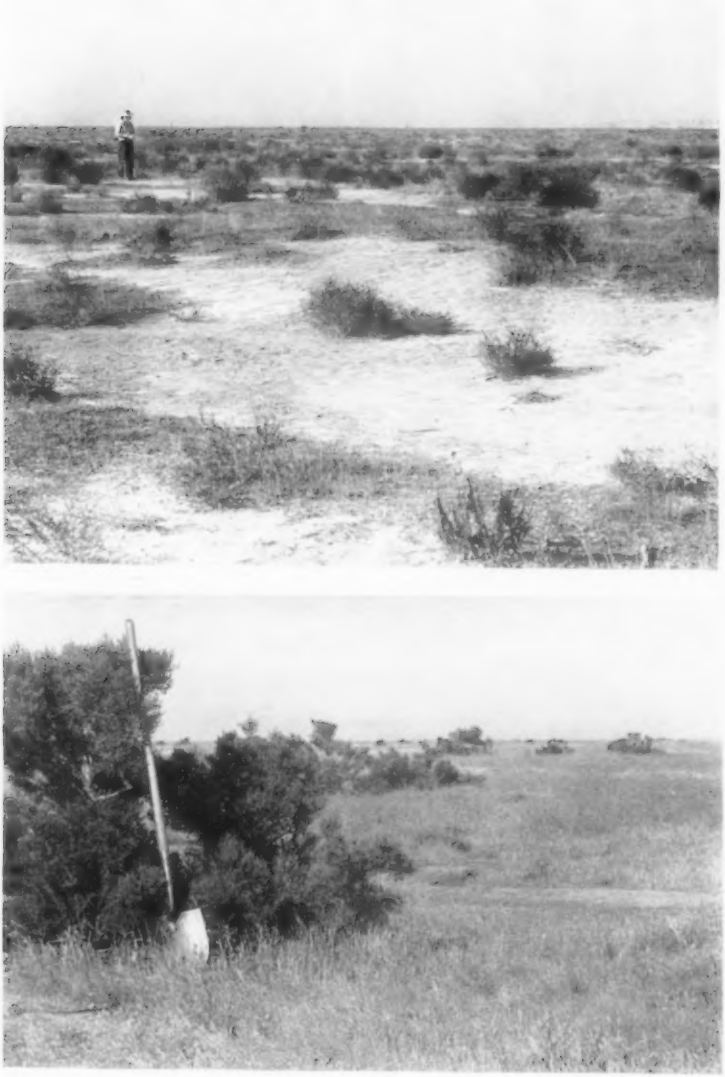

PLATE 1

UPPER: Photograph at station 1. A characteristic habitat of *D. n. exilis*. Elevated grassy patches occur scattered over the alkali plain. The larger plants are alkali blite (*Suaeda moquini*).

LOWER: Photograph at station 2. Scattered clumps of iodine bush (*Allenrolfea occidentalis*) on the level grassy terrane. The white patches are alkali.

PLATE 2

UPPER: Burrow system of *D. n. exilis* on a grassy elevation (white marker). The two arrow markers indicate burrows of *D. n. tularensis* showing the close proximity of these two species.

LOWER: Characteristic fan-shaped distribution of excavated dirt. The tape measure case is three inches in diameter at the position of the hole.

BURROW SYSTEMS

The burrow systems occur in a variety of soil conditions. Nowhere do they occur where the soil is heavy and no rocks were encountered in any places where excavating was done. The major portion of the area studied to date is indicated on the soil map (Holmes, *et al.*, 1921) as Fresno sandy loam, with alkali almost everywhere. Alkali is characteristic of regions of little rainfall and where there never has been enough surface water to develop a system of drainage. The salts accumulate, on evaporization of the water, near and on the surface. In many places this accumulation encrusts the surface when dry and bakes hard and in others becomes a fine, powdery dust. The alkali is of the white variety, that is, containing less of the carbonates of sodium and potassium and more of the chlorides, sulfates, and nitrates. Hardpan at varying depths is characteristic of most saline soils. Weaver and Clements (1938) believe this is probably because of the removal of humus and the production of impervious colloids.

Weaver and Clements list certain halophytic plants as indicators of different degrees of alkalinity. Species of *Atriplex*, *Allenrolfea*, *Distichlis* and *Suaeda* are the ones used most. Plants of these species are to be found from scattered stands to pure associations covering considerable areas. The surface may be baked and hard in the dry part of the year so that it would be impossible for such a weak digger as *D. n. exilis* to make new openings to the surface. In excavating in such places one has to make several attempts with full weight on the shovel to get through the first six to eight inches. Under this layer the soil is soft and fine and is easily dug down to a hardpan layer which varies in depth to five or six feet.

It is difficult to pick out a typical burrow system for some are more extensive than others. At station 1 the surface area varies from about 7 by 7 feet to 12 by 12 feet. It might be well to note here that the size of the area of the workings of kangaroo rats varies somewhat directly with the size of the species. Shaw (1934) gives measurements of dens of *D. ingens* as 17 by 21 feet and 17 by 22 feet. *D. h. tularensis* dens are intermediate in size between *D. ingens* and *D. n. exilis*. The number of surface holes in *D. n. exilis* dens is variable and there are usually two kinds of openings, slanting and vertical. There is usually one vertical hole through which no dirt has been thrown out but which was excavated by the animal from the inside. It may be full size and open, plugged, or only partly finished. These serve as escape holes or exits. The slanting holes are several in number, two or more of them being in general use. There are other openings which are not in regular use as is shown by broken down edges, the caved in condition, or the presence of spider webs. Holes may be in use yet will show no newly excavated dirt for long periods of time. Specimens have been trapped at dens where no new dirt has been excavated for several months.

One occupied den that was dug out covered an area 6 feet square. Some new dirt had been excavated by the animal but all of it had come from the softer layer under the hard top layer. The regular tunnels were 2 inches in diameter and 8 to 10 inches below the surface. One enlarged pocket, 5 by 5 inches, was $5\frac{1}{2}$ inches from the surface (to top of pocket). Another pocket was 6 inches below

the surface. The bottoms of the more shallow tunnels were dry and dusty while the deeper ones and the pockets had the bottoms covered with damp earth. The earth in the bottoms of the pockets was also mixed with seed

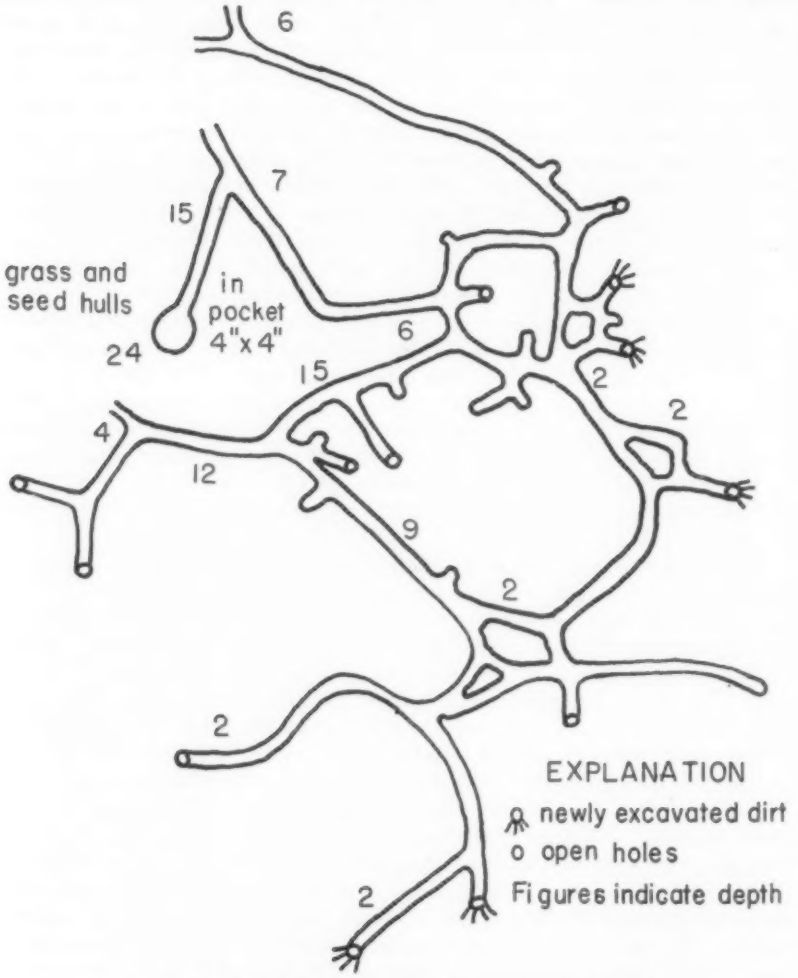

FIG. 1. Burrow System of *Dipodomys nitratoides exilis*

hulls. There was no nesting material and no stored food. This burrow system was very shallow and it is difficult to see how the animal escaped the heat of mid-summer (115° F.) in such shallow tunnels and with the openings not plugged.

Another system dug out had a surface area 9 feet square (fig. 1). One hole

went down 24 inches into damp earth where hardpan was encountered. A blind side pocket was 8 inches below the surface and was covered on the bottom with damp earth mixed with seed hulls. In the process of digging, two young animals ran out but returned to find other openings, which they entered. One got into the diggings and was caught while the other went down one of the holes. In completing the digging this specimen was not found. It may have escaped unnoticed. A trap set at this den had previously caught a juvenile so that it would appear that the den was occupied by three young kangaroo rats. No evidence of an adult was found.

Not all the burrows of one system are always connected. In digging out a system, an open hole was followed and very soon a kangaroo rat went out another hole, which proved to be the other end of the same burrow about 3 feet long. These short, subsidiary burrows are "duck-in" holes for safety. In this system the digging was carried to a depth of 36 inches ,the deepest burrow was 30 inches down and had no enlarged pocket.

An attempt was made to determine what the animals would do with oatmeal left by a burrow system. One evening a considerable pile was placed by the openings and it was all gone the next morning. The den nearest the pile was excavated. Only one place was found where there was oatmeal. About a dozen flakes were in a little pit in the wall of an enlarged pocket. These pits were doubtless made in the same manner as the ones made by captive animals. The rat digs rapidly with its front feet, sometimes kicking away some of the dirt with its hind legs, until a pit is made that will hold the contents of the cheek pouches. The pouches are then emptied into the pit and the dirt quickly scraped over and patted down.

Piemeisel and Lawson (1937), in their study of the types of vegetation of the San Joaquin Valley, mapped the area under consideration as Pacific grassland and lowland. On such land the distribution of the lowland types of vegetation is dependent on underground water rather than directly on precipitation. This underground water is no doubt responsible for the dampness of the earth at the bottom of the burrows. After digging through the hard baked top layer and into the loose layer beneath, the soil is damp enough to stick to the shovel. In summer that part of the burrow system near the surface is in dry soil. Everywhere the bottoms of the burrows are covered with loose dirt, nowhere are they packed and hard. During the winter rainy season the entire burrow system is damp. It would seem that there would be no dry, dusty earth for dust bathing at this time of the year. Grinnell (1932) indicates a requisite condition in the distribution of *D. ingens* is a region where there is dry dirt at all times somewhere in the burrow system. On the other hand, *D. n. exilis* lives in burrows that are damp throughout for a part of the year. This may also be responsible for the lack of food storage by this species. Seeds could not be kept dry enough to keep them from sprouting or molding.

Surface runways are not exactly a part of the burrow systems but are closely associated with the openings and should be considered here. Most species of kangaroo rats have beaten and cleared pathways radiating out from their burrow entrances. The grass is cut or trodden down so as to make clear

pathways for traveling about and collecting food. The runs of *D. n. exilis* are not present in all places. Where there are bare areas between the burrow systems, these are used and often have well beaten trails running over them. Specimens have been trapped in these bare areas considerable distances from any holes.

FOOD AND STORAGE

Observation of food storage, for the most part, has been negative. The only stored food found in excavating burrow systems has been in small pits, holding about the contents of the two cheek pouches. These pits were scratched into the sides of the tunnels or in the enlarged pockets which occur only in some systems. Some small quantities of seeds and green plant pieces have been found in and under nesting material. A common place for storage with captive animals is under the nesting material in the nest box. There was no quantity of food stored as described by Shaw (1934) for *D. ingens*, nor as described by Voorhies and Taylor (1922) for *D. spectabilis*. Tappe (1941) describes food storage by *D. h. tularensis*. His work was done in the drier western part of the San Joaquin Valley. He reports no considerable quantities of stored food.

It would seem that different species of kangaroo rats develop the storage habit in some proportion to the degree of desert condition where they live. In the region inhabited by *D. ingens* farther west there is very little vegetation as compared with that occupied by *D. n. exilis*. Sometimes *D. ingens* are trapped in areas that are almost devoid of vegetation, particularly after sheep have grazed over it. At the stations where work was done in the summer of 1942, there was plenty of grass and with some seeds still in the heads. This makes a food supply available for *D. n. exilis* over a long period of time so it seems that the storage habit is, therefore, not well developed.

Voorhies and Taylor (1922) "suspect" that *D. merriami* pilfers the stored food supply of the larger species, *D. spectabilis*. Two rodents of similar food habits, occupying the same area must have some interesting food relations. This was considered to be a part of the study of *D. n. exilis*, since the larger species *D. h. tularensis* occupies the same region. Traps at adjacent burrow systems often catch one of each species (Pl. 2, upper). Trapping at station 1 showed nearly equal numbers of the two species. Trapping at station 2 resulted in 81 individuals of *D. n. exilis* and only 9 individuals of *D. h. tularensis*. There was no effort made to avoid trapping at *D. h. tularensis* holes. It appears that the population in this area is predominantly *D. n. exilis*, although this doubtless would vary from year to year. In excavated burrow systems of *D. h. tularensis* no quantities of stored foods were found. These two species seem to compete for food on the same basis as any other two animals of different size.

AVAILABILITY AND USE OF WATER

The region occupied by *D. n. exilis* is dry from early spring until late fall. Green vegetation is available in only a small part of the year. There is no surface water other than temporary rain pools during the rainy season. In the dry part of the year the most abundant green plants are saltbush, iodine bush,

salt grass and alkali blite. Very small quantities of alkali blite have been found in the burrows of the rats. During the time when green vegetation is available, some pieces of plants, such as pieces of pepper grass, are cut and have been found in the nests. Corms of *Brodiaea capitata* are available but there is no evidence that the animals use them. In the dry part of the year, *D. n. exilis* probably could not dig the corms out. The larger plants named above do not offer any source of water. Dew forms occasionally, even in the summer, and offers a possible source of water.

Babcock (1912), in his paper on metabolic water, states that "in the life history of both plants and animals there are stages in which the metabolic water is sufficient for all purposes for considerable periods of time". Foods are capable of producing a quantity of water equal to the weight of the hydrogen. The chief use of imbibed water is to remove waste. Metabolic water, in most cases, is sufficient for transferring nutrients and replacing the ordinary loss from respiration and evaporation. Specimens of *D. n. exilis* have been kept in dry cages, without water, and fed only air-dried food for three months without any noticeable ill effects. One specimen was kept for some time on a dry diet and then given some green grass, which was cut into pieces by the animal and stored in the nest box. Water was also supplied. The animal got its feet wet, licked off some of the water, then made haste to find a dry place in which to roll and get dried off.

Animals kept captive in the summer have not been supplied with water except what they obtained from freshly cut grass of which they ate very little. Captive animals had more fat on them than newly captured specimens mainly because no provision was made for exercise in the cages.

The amount of urine eliminated is very small and the feces are characteristically dry.

From all available evidence, *D. n. exilis* gets along for considerable periods of time with no free water.

ENEMIES

No direct observations on the capture of *D. n. exilis* by other animals have been made. It is only by inference and the occurrence of possible predators in the area that one can make a list of possible enemies.

Predatory birds were mainly represented by the American marsh hawk (*Circus cyaneus hudsonius*) and the western burrowing owl (*Speotyto cunicularia hypugaea*). These two species were regularly seen every time work was done in the field. No kangaroo rat has been observed outside its burrow in the daytime unless it was known to have been driven out. It seems unlikely, then, that the American marsh hawk captures many kangaroo rats. The remains of Fresno kangaroo rats in burrowing owl's pellets were observed but once. These little owls are distributed generally over the area where *D. n. exilis* is found, but perhaps the rats come out too late in the evening for the owls. Barn Owls (*Tyto alba*) are potential enemies, but there were few suitable places for these birds to roost and nest.

Badger (*Taxidea taxus*) diggings were present in many places. The remains

of one badger were found at station 2. Coyotes (*Canis latrans*) have been heard and seen. It is questionable whether these animals could or would dig through the hard surface layer in summer. It may not always be necessary, however, for them to dig out the entire burrow to catch the rats. When a burrow system is being excavated the animal frequently escapes long before the ends are reached. Kangaroo rats may leave the burrows when a badger or coyote is scratching, and the capture may be made while the creature is attempting to gain entrance to another hole. At one time the kit fox (*Vulpes macrotis*) may have been an important enemy of *D. n. exilis*. At present this small fox is mostly confined to the southern end of the San Joaquin Valley and rarely occurs on the area covered by this study. Few Pacific rattle snakes (*Crotalus viridis oreganus*) were observed. A single gopher snake (*Pituophis catenifer*) was found. One long-nosed snake (*Rhinocheilus lecontei*) and one California king snake (*Lampropeltis getulus californiae*) were also taken. All these snakes are potential enemies. Seton (1929) suggested that scorpions, which were commonly found when digging out the burrow systems, may be enemies of kangaroo rats, at least of the very young ones.

As far as the kangaroo rat population is concerned, man is the chief enemy. These animals are not able to maintain their burrow systems and live in areas under irrigation and cultivation. However, they reinvade fields no longer cultivated. Much of the land where *D. n. exilis* is found at present is so heavily alkaline that cultivation is not feasible.

PARASITES

This kangaroo rat is not infested with many external parasites. Ticks (unidentified) were found occasionally on the ears and under the chin or other parts of the body. Careful search was made of all of the specimens captured with the result that only some half dozen ticks were collected. Few fleas and no lice were found. Frequent dust bathing seems to be effective in controlling external parasites.

OTHER ASSOCIATED ANIMALS

Other small mammals that live on the areas and may compete with the Fresno kangaroo rat were scarce. As before mentioned, the region is also inhabited by another larger species, the Tulare kangaroo rat (*D. h. tularensis*). Other species of small mammals include the Fresno pocket gopher (*Thomomys bottae pascalis*), Gambel white-footed mouse (*Peromyscus maniculatus gambelii*), long-tailed harvest mouse (*Reithrodontomys megalotis longicaudus*), Tulare grasshopper mouse (*Onychomys torridus tularensis*), San Joaquin pocket mouse (*Perognathus inornatus inornatus*), and the Beechey ground squirrel (*Citellus beecheyi beecheyi*). Except for the pocket gophers and the pocket mice, the other small mammals are limited mainly to the bush habitats in the area.

Many species of invertebrates were associated with the burrows of the kangaroo rats. The dentate eleodes (*Eleodes dentata*), the California camel cricket (*Ceuthophilus californianus*), and unidentified species of scorpions and centipedes were

found in nearly every burrow. They were usually not in the main tunnels of the burrow system, but rather in unused portions. Several black widow spiders (*Latrodectus mactans*) with large cocoons filled with eggs were found in unused portions of the burrows. Unidentified species of harvester ants (*Pogonomyrmex*) were common but did not occupy the burrows. The entrance of their nests were marked by low chaff-covered mounds, radiating trails, and a considerable area that has been cleared of vegetation. These ants would seem to be important competitors of all seed-eating rodents.

OBSERVATION ON CAPTIVE ANIMALS

A number of cages, with nest boxes, were constructed for observation of captive specimens of *D. n. exilis* and an attempt was made to obtain young for study. Trapping was done with live traps constructed of tin cans, and with wooden box traps.

One of the first problems was to determine whether more than one specimen could be kept in a cage. Accounts of kangaroo rats generally state that two individuals will not live together; that they will fight until one of them is killed. It seemed desirable to keep all the females separated. A box 23 by 35 inches was prepared with about 8 inches of soil in the bottom and screened over the top. Six males were placed in this box and they immediately started fighting. They stood on their hind feet, sniffed at each other, then suddenly one would leap over the other, attempting to kick as it went over. This continued for some time with two, and even sometimes three, fighting at once. There were also rough and tumble fights with considerable biting. No great harm seemed to result to any of the combatants. The next morning, after a rather cool night, all six animals were huddled together in one corner of the box. They did not attempt to dig burrows for a couple of days but when they did they lived together without any more fighting. Several young individuals have been kept together without fighting. Male and female specimens are not compatible unless breeding.

Kangaroo rats are notably averse to getting wet. Often when water was placed in a cage and they got into it accidentally, they went immediately to a dusty, dry place to rub and roll, in order to get dry. The six males were subjected to a "drowning out" process by turning water into the box. Considerable water ran in before the bedraggled animals came out. The surface of the earth in parts of the box was dry. One of them scratched and kicked in this to make a small depression, then turned on his side and pushed his body through it. This was repeated several times, changing sides, resulting in its getting fairly dry. The tail was groomed by rapidly running it through the front paws as they were held against the mouth.

Nest building in captivity varies considerably with the individual. Even with nesting material available, several specimens used the empty box. Burlap and grass were supplied but only some of them used this material. After the shredding, a nest was formed by rapid movements of the front feet resulting in pushing the material up and over the body. Blocking the hole of the nesting box seems to be an individual matter, also. Some of them left the entrance open; others kept it plugged rather completely.

The cages were not supplied with water. Freshly cut grass, which was seldom eaten, furnished the only moisture. On hot days grass that had been dipped in water was placed in the cages but no use was made of it. Occasionally water would get on the animals' front feet and be licked off, but they were never observed to drink. Dry oatmeal, rolled wheat, or rolled barley was fed each evening. When first placed in captivity, the animals would fill their cheek pouches and carry the material to some part of the cage and store it. Some food was stored in the nest box under the nesting material. After a time in captivity most of the food placed in the cage was not picked up. Some of the animals were kept for three months on a diet of dry wheat with no water and no green material. They seemed to get along satisfactorily.

Droppings were scattered everywhere in the cage and on top of the nest box. A place was regularly chosen for urination, usually in a corner of the cage but often on the top of the nest box.

Activity in the daytime was limited. When examined in the day-time the animals were asleep or resting in an upright position with the feet under the body and the head depressed. On hot days, however, their behavior was somewhat different. Then they left the nest box and sprawled out in the dirt or on the dried grass. The legs and head were extended, respiration was slow and there seemed to be an adjustment to reduce the rate of metabolism as well as to expose more body surface to the air.

Observation on the method of digging burrows was made on captive animals. Several individuals were placed in a large box of earth that was slightly packed. After prospecting around for a time they started digging. One male was watched more than the others. He stood firmly on his hind legs, which were spread well apart, and scratched rapidly with the front feet. The dirt was pushed back under his body, then with several strong kicks with the hind legs the dirt was sent flying backwards. As the hole became deeper the dirt accumulated and got in the way. He would then turn around, come out of the opening, and push the dirt a little with his front feet. When he turned and started down the hole he kicked backward, scattering the dirt away from the hole. On the next trip to the opening, the accumulated dirt was kicked backward as the animal moved backward. This backward moving and kicking carried the dirt some distance from the hole. As the animal returned to the entrance there was also some kicking of the dirt all the way. Each successive trip moved the dirt farther away and in different directions, resulting in a more or less fan-shaped distribution (Pl. 2, lower). Mounds of any size would be a hindrance, interfering with the rapid entrances the animals have to make when pursued or freightened.

BREEDING AND YOUNG

Attempts to get the Fresno kangaroo rat to breed in captivity have not been successful. Observations have been made on young born in captivity, however, of which only one lived for any length of time. The maternal instinct for the care of the young seemed to be too greatly disturbed by the new surroundings of captivity. The mothers usually built no nests and the newly born young were for the most part found dead and discarded.

Seven young from four litters averaged 2.2 (1.5 to 3.5) grams in weight at birth. This is a rather large range in weight and suggests that the smallest ones were not full term. The smallest young were in a litter of three with a total weight of 4.4 grams. Single births produced the largest young. Two born at one time weighed 2.56 grams each. Two young at a birth is believed to be the average number and the average weight is about 2.5 grams.

Observations on young kangaroo rats are confined here to the one individual, one of two born June 23. The other one died shortly after birth. After the mother started to care for the young one it nursed from two teats, one pectoral and one inguinal. There are three pairs of mammary glands, two inguinal and one pectoral. When nursing, the mother assumed a position over the young one which lay on its back. When disturbed while nursing, the young one hung on the teat while the mother moved about.

Growth of this captive young one was not very regular, although it is probably the usual thing. Weight at birth was 2.5 grams. The next day it was 2.4 grams.

TABLE 1.—*Changes in measurements*[1] *and proportions of young kangaroo rat*

	BODY	TAIL	FOOT	WEIGHT
At birth	30	10 (33.3)	10 (33.3)	2.5
10 days	40	32 (80)	18 (45)	5.0
17 days	57	58 (100)	27 (47.3)	9.0
33 days	75	110 (146)	32 (42.6)	16.9
40 days	76	117 (154)	32.5 (42.1)	19.1
Av. adult	83	139.4 (168)	33 (40)	31.26

[1] Measurements in millimeters. Weights in grams. Numbers in parentheses are percentage of body length.

Even at this age the young one could belly-crawl off the pan of the scales. It made a continuous wheezy-squeeky sound as it was crawling about or when picked up. Weight doubled in 10 days and trebled in 15 days, at which time it could stumble about on all four. The eyes opened on the 13th or 14th day, a mere slit at first. At 20 days it ate some solid food and nibbled at some fresh grass. At 35 days the weight was 17.8 grams, at which time it was observed to fill its pouches and store food in the corner of the cage. This it did after true adult fashion by digging a small pit, emptying its pouches, and pushing the dirt over the deposited food. At 39 days the weight was 19.7 grams; on the 40th day it weighed 18.7 grams; and on the next day it was dead. No cause could be ascertained for its death, as it was lively and active the evening before.

When the young one was left out of the nest box after weighing, the mother would pick it up and carry it in. She accomplished this by grasping the young one with her mouth across the middle of the back. This was done even at the age of 30 days when its weight was 18.5 grams. When the young one was taken out to be weighed, the mother would rearrange the nest material, looking out frequently to see what was going on.

Measurements taken at birth were: total length, 40 mm; tail, 10 mm; hind foot, 10 mm; the ear, at birth, was folded over so as to close the meatus and was 1 mm long. At five days the measurements were 72-32-18; at 12 days, 115-58-27 and the ear 3; at 26 days, 185-110-32-7; and at 40 days, 193-58-27-7.

Gain in weight varied in 24-hour periods from zero to one gram. The average gain was 0.5 gram per day. The body, tail, and foot proportions at birth are considerably different than in the adult. These are presented in Table 1.

The table shows a rapid and continuous elongation of the tail. The hind foot, however, rapidly increases in length, attaining nearly adult size at the age of one month.

It was thought that the weights and measurements of a young individual might give some basis for judging the age of trapped specimens and thus determine the age when the young leave the nest to forage by themselves. The captive young one weighed 18.5 grams when 36 days old. A wild trapped juvenile weighing 18.5 grams was much more mature, had lost some of the mouse grey color, and had acquired considerable crest and tuft on the tail. The captive young one, on the other hand, was mouse grey, had no tail crest or tuft and appeared very young. Using captive young kangaroo rats to determine the age of trapped specimens would appear not to be very reliable although it seems likely that the young ones are out foraging for themselves when about six weeks of age.

Breeding extends over most of the year. Adults containing embryos or young born in captivity are recorded for February, March, June, July, August, and September. Half-grown specimens have been taken in months that would indicate breeding in the other months.

SUMMARY

D. n. exilis, the smallest of the kangaroo rats, occupies a limited area in the central portion of the San Joaquin Valley. The original range has been greatly reduced because of cultivation and irrigation. *D. h. tularensis* occurs in the same area: the two species are competitors. The terrain occupied is the generally level valley floor. Only slight irregularities are present over the area, much of which is characterized by patches of alkali. Burrow systems are confined to the slight elevations.

Food storage is very limited; small caches are placed in small pits in the sides of the burrows or in the nests. The burrow system is damp in all portions during the rainy season, precluding extensive storage of food. A satisfactory food supply seems to be available throughout the year, hence food storage is not necessary.

Breeding extends throughout the year. The average number at a birth is probably two.

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NOTES ON DORMANCY IN THE BLACK BEAR

BY J. R. MATSON

In his book *The Minds and Manners of Wild Animals* published in 1922, William T. Hornaday says, "It is unfortunate that up to date no bear student with a tireless pen has written The Book of Bears. But let no man rashly assume that he known 'all about bears'. While many bears do think and act along certain lines, I am constantly warning my friends, 'Beware of the Bear! You never can tell what he will do next' ". Although it is evident from the text that Hornaday referred especially to bears in captivity, his words might well be used today to describe the present state of knowledge concerning the ways of bears in the wild.

A fund of bear lore has attained a degree of authenticity by repetition. Childhood impressions, from nursery books and the tales of our elders, tend to influence our mature opinions. Snap judgements of superficial observers and conclusions by would-be naturalists, reached by the "two-plus-two method," have added to our confusion. What is known as "common knowledge" is widely accepted, without question, as fact. Wildlife authorities have been cautious and brief in their statements regarding bears in the wild state.

Casual remarks by woodsmen and hunters have been used to substantiate fanciful theories. It is a characteristic of the back-woodsman that he avoids argument on matters of no material consequence to him. He is disposed to be agreeable to strangers, and he will seldom risk his credibility before those whom he regards as his superiors in "book larnin." There is wisdom in the backwoods philosophy "in forty years it won't matter, so why argue?" Thus many

unfounded theories regarding bears have been affirmed by "old hunters" as a matter of politeness. Some writers substantiate their statements by such proof as "my guide agreed . . . ", or "it is common knowledge among the natives."

It is true that the bear's adaptability to varying conditions of climate, cover, and food is great. For that reason the findings of a single observer seldom justify general conclusions. "You can never tell what a bear will do" is a remark often heard, carrying the implication that the ways of bears are beyond understanding. But there are no good reasons for not seeking the facts, and reporting our observations with confidence.

In the fog of legend and mystery it appears that we have not recognized certain fundamental characteristics of bears, and we have failed to form a working hypothesis from which to reach an understanding of their ways. Statements made here are offered with the hope that they may be of value, in connection with data from a wider field, in working out a true theory regarding the so-called hibernation of bears. These statements can be verified in each instance by reference to the individuals concerned. I am convinced that many life-long residents of bear country have observed some or all of the conditions to be mentioned but have attached little significance to them or have failed to correlate their observations and bring them to attention.

There are men who have had long-continued opportunity to observe bears in the wild state, but with few exceptions their interest includes only the sport of hunting, or the "hide 'n taller" and other commercial considerations. The mere killing of bears has not added materially to our knowledge of their characteristics. To study wild bears, an intimate knowledge of considerable territory is essential—and also unlimited time. These conditions have handicapped scientifically trained observers.

The bear population is small in relation to that of other animals of comparable size. Ordinarily bears are of a shy and retiring nature where man is concerned and few sportsmen who spend their vacations in the woods ever see one. When a hunter contemplates the vast tracts of forbidding territory in which there may be a bear, he may well feel that his quest is like hunting for a needle in a haystack. The factors of "time and space" account largely for the lack of accurate information regarding bears in the wild.

Any large animal not primarily a grazer or browser requires extensive range to furnish adequate food supply. In his ceaseless quest for food one bear will leave enough sign to give the impression that the woods are full of bears. He will dig a ton of earth for a few grubs or roots and will trample an acre of bushes for a meal of berries. Overturning large rocks and rending rotten logs are not too great a price to pay for a chipmunk or a few ants. He will twist and break limbs to get the last apple, and will wreck a growth of mountain ash, chokecherry, or wild grape for the fruit. While absorbed in rooting the leaves for nuts, he has been known to feed to within arm's length of a patient watcher; and while thus absorbed he has been approached and nearly touched by the hand of a skillful stalker. A bee-tree will engage his efforts for days. Although he does not deserve the stigma of "predator" in the usual sense, he will occasionally kill

his own meat and will steal meat killed by others at every opportunity. He is a fisherman, but his delicate nose is not offended if the fish have been a long time dead. When on short rations, as in early spring, he will eat grass and twigs. He is omnivorous in the full sense and his industrious application to the job of eating throws some light on dormancy. "As fat as a bear" is a well founded simile.

I have never heard the theory advanced that bears become dormant because it is impossible for them to eat more, but there is evidence that this is true. My intention is to report the testimony of witnesses and personal observations, selected from a lifetime of lumbering and hunting in the eastern states. The verdict will be left to the jury.

Before attempting a discussion of this it would be practical to distinguish between the dormant state assumed by some animals under certain conditions (which we associate with the disappearance of bears during the winter period and commonly called hibernation) and the torpid state of other mammals, which is true hibernation. It is a scientifically accepted fact that the carnivorous animals (including bears, coons, skunks, badgers, etc.) do not hibernate. They do go into a deep sleep, but their respiration, rate of heart beat, and body temperature are not drastically reduced as they are in true hibernation. They are relatively easily aroused from sleep and seem to have full sensibility and use of their faculties. On the other hand, true hibernators (ground squirrels, woodchucks, etc.) are found to be in a state resembling death, from which they can be aroused with difficulty. .They may be handled without awakening, feel cold to the touch, show slight sensitivity, respiration and heart beat barely perceptible—a state of suspended animation. The bear is carnivorous and is not a true hibernator. He may, and frequently does, become dormant in warm weather.

Before bears were rigidly protected in Pennsylvania, our hunting party killed numbers of them in fall and early winter. In the light of later experience it is now evident that our success was due largely to the qualifications and management of that party. All were intimately familiar with the country hunted, having been engaged in the lumber operations of those areas. While capable of acting independently in any situation, they were schooled in the discipline of the lumber camps. Their efforts were coordinated by an older man who acted as foreman; whose directions were accepted willingly and carried out faithfully. Reports were made and conditions were discussed each night. Our plans were based on known food supply, lying places, and runways of the area we proposed to hunt. With this information in mind the foreman planned the following day's hunt and assigned tasks to each individual. We performed our functions as part of a day's work. We had no accidents or misadventures over a period of many years. These conditions are mentioned as being vital to success.

Parts of our hunting country were covered by a dense growth of brush and briars (blackberry) which had sprung up following extensive forest fires. This cover was almost impenetrable by men. In such areas we used two or three dogs to rout the game. The dogs could seldom hold the bear firmly at bay in such cover, but they kept him in motion and advised us of his movements. In more

open cover (feeding grounds of oak and beech), members of the party scouted for feeding bears while other watched at 'runways' or 'crossings' nearby. Both methods were used when there was little encouragement in the way of food or sign.

We noted little evidence of bears in our hunting country in a year when both fruit and nuts were scarce. When both were plentiful there was much evidence during late summer and fall. If the berry and fruit crop failed, the evidence of bears did not appear until, and unless, a crop of nuts was available in late fall. In such cases they continued their feeding later in the season than when fruit had been plentiful. When both the fruit and the nut crop failed, the few bears that were in evidence continued their travels after snow and cold weather came on. Such travel was observed (although rarely) when the bear's body ploughed a groove in the deep snow.

In the foregoing statement I have used the words "evidence" and "presence," as bears may be present, occasionally, in areas nearly devoid of food and leave but little evidence on bare ground. In such cases they travel widely and the chance of finding them is too slight to make hunting them worthwhile. The ideal place to observe or hunt bears is at or near their food supply.

From such observations we made the obvious deductions that bears travel a wide range; that the bear's physical condition, not temperature or weather conditions, governs the time of becoming dormant; and that in case of failure of food supply the few bears in evidence do not become dormant, but continue roaming about until conditions make winter travel impossible. We reasoned that the accumulation of fat is an instinctive preparation for a period of food scarcity, as in the case with squirrels storing nuts.

But we were puzzled when bears, feeding actively on favorite food, suddenly and completely *disappeared* from our hunting country in mild fall weather *when food was still plentiful*. The fact that they left favorite food *in mild weather* did not check with our preconceived notion that dormancy is caused by cold weather. Although we had quite commonly found them moving about in snow and cold weather, we had regarded that fact as "exceptional"—one of the unaccountable ways of bears. However, we could not square their leaving favorite food with our understanding of their voracious appetite and gluttonous nature. At first we thought their disappearance to be a local matter, but in time we found that it was general and simultaneous over considerable portions of their range. If they were not here in mild weather and while food was plentiful, nor in other localities where, we ascertained, similar conditions prevailed, then where were they? We reached the unsatisfactory conclusion that they had "migrated" to distant parts beyond the reach of our investigations. How they might have reached those distant parts in such short time and without leaving a clue to their movement in the intervening areas we could not understand. We dismissed the question with the time-honored remark, "You never can tell about bears." Many years passed before we found a plausible solution of that problem.

During those years we examined the viscera of bears and noted that in some cases the digestive tract was gorged—in other words the bear had been feeding

heavily. At the same time (in November and December) and under the same conditions, we found others in which the digestive tract was entirely empty and shrunken. In such cases the animal was extremely fat.

As time passed, we became aware that bears killed after being routed from feeding areas (oak and beech ridges) were almost invariably the ones having partially filled or well filled stomachs; while the ones having empty and shrunken stomachs and intestines were the ones routed from the high benches and ridge-tops, where dense cover made access difficult.

Eventually, we chanced to kill one at the very instant he was routed from his bed in the blow-downs and dense brush of a ridge-top. His bed was simply a shallow depression which he had dug and into which leaves and twigs had been raked. Droppings surrounding his bed at a distance of a few feet indicated that he had risen only to empty his alimentary tract. The condition of the droppings indicate that he had occupied the bed a week or two. This was in mild weather in November, when nuts were plentiful on adjacent ridges, and apples were available at old orchards a few miles away. Evidently this bear was "fed up" and had retired for a long sleep. The stomach was shrunken to practically a solid ball the size of a man's fist, and it felt firm to the hand. In our estimation this bear was *physically incapable* of taking food. This was not an isolated case. A similar condition was noted in other cases. At the same time, other bears which had not been so fortunate, or so industrious, were found feeding on the hardwood ridges, indicating that they had not yet accumulated sufficient fat to suspend digestive action.

We felt quite "set up" by the importance of our discovery, and we made some attempt at reporting it. Due, probably, to the restricted scope of our observasions, (and our clumsy attempt at reporting), our findings were regarded merely as "interesting" and "exceptional." We encountered the complacency of "common knowledge." Our flaming torch of enlightenment seemed to sputter and lose its brilliance in the rarefied atmosphere of science. In other quarters we ran into a fog of theory and trivialities, and we thought we detected the unmistakable scent of policy—and politics. Our regard for the "authorities" was not enhanced by our venture as reporters in the field of natural science.

On the other hand we had no position to maintain, no job to defend. As the saying goes, "we had not lost any bears," so why argue? Our reports made good bear stories for the home folks, and we let it go at that.

With the passing of years, changing conditions broke up our hunting party. Although some of us continued to hunt bears in a hit-or-miss way in other parts of the country, we learned, by indifferent success, that hunting bears in strange lands with inexperienced companions is unprofitable, even as sport. Not until then did we realize the advantages of an experienced party, each member of which is able to depend on his own resources, his ability to travel fast and far when necessary, and his intimate knowledge of the lay of the land. We learned that the quest for bear is not the cut-and-dried matter we had known; that, as generally practiced, it is a matter of luck.

Twenty years later the writer was notified (about October first) by friends in

northern Vermont and New Hampshire that bears were unusually active at the time in familiar cut-over areas in those states. A few days were required to arrange for an extended hunt, but by mid-October we were on the ground for an indefinite stay. We found plenty of old bear sign, but little fresh sign, in localities where it had been plentiful two weeks previous. This disappointing fact was accounted for by friends in Vermont with the opinion that the bears had "probably gone over into the White Mountains of New Hampshire." In New Hampshire they had "gone over into the Green Mountains of Vermont" or "over into the lake country of Maine." In Maine they had "gone back into the swamps where roots and bulbs were plentiful," or "back into the New Hampshire mountains."

This situation was identical with that observed long ago in our old hunting country. Fruit and nuts had been plentiful and bears had been active. They had suddenly and mysteriously disappeared over a large portion of their natural range—in this case known to be portions of three states. The local explanation of their disappearance was identical with our early belief that they had "left the country for distant parts where food was more plentiful."

Here was an opportunity to corroborate our 20 year old theory (based on the coincidence of their disappearance and their shrunken stomachs) that bears become dormant because they are "fed up" and can eat no more. In this case, due to the advance made in transportation and communication facilities, the situation could be observed over a wider area, and the testimony of more hunters could be included. By this time I was more interested in studying bears than in killing them. My northern trip was extended into the winter and included localities in each of the three states mentioned, with results as stated.

My contacts were with local people whose interests and inclinations keep them in continuous residence in bear country. With two or three exceptions they were still-hunters, whose method is to scout for feeding bears in oak or beech woods, or simply to watch for them at old orchards. My still-hunting friends were convinced that the bears had "disappeared" (and later in the season, that, "they had holed-up for the winter") and that it was useless to hunt for them. The exceptions mentioned were hound-men who quite naturally were interested only in hunting with their own dogs. I had eight hounds with me, of which six were young dogs that I wanted to give some bear experience. Under the circumstances, I was obliged to go it alone, depending on my two older dogs and an occasional day's help from one or another of my friends. My object was to find the bears that had "disappeared," and to establish further the connection between their disappearance and dormancy.

The hurricane of 1938 had flattened much of the timber in the White Mountains around the 2500 foot altitude. Hunting was forbidden by fire-laws in much of this down-timber, but certain areas were not closed because it was considered impractical or impossible to negotiate them. However, I was convinced that the missing bears had "disappeared" to the high benches of nearby mountains and that they were bedded in those jungles of down-timber. In late October and early November, during mild weather and before the first fall

of snow, I had some experiences that I would not care to repeat. I found bears in those blow-downs where they were ordinarily safe from disturbance, except by dogs. It was impossible to keep contact with a chase and the dogs could not hold a bear at bay in such cover. But I did find that bears do not necessarily cross state lines when they suddenly abandon their feeding grounds in mild weather, nor do they (at least not all of them) go into holes or dens for their long sleep.

Although there was occasional evidence of a bear moving about, these instances were rare. In general they were not moving. Although several bears had been killed by still-hunters in the general vicinity a few weeks earlier, none was killed by still-hunting (to my knowledge) during the period after they had "disappeared." They had in fact "disappeared," but they had not "left the country."

At this point I shall relate one of those incidents rare in bear hunting, when several significant details could be observed at one time and all witnessed by a second party.

Accompanied by an experienced hunter and four hounds we were standing on a high bench of Mt. Kineo in Grafton County, New Hampshire, at noon on October 30, 1941. Although we were a hunting party, we were not actually hunting at the time. We had left our rifles in camp to do a little prospecting and had travelled farther than intended. It was a mild day and the ground was bare. We were not prepared for what followed—my companion was wearing a pair of sneakers. The dogs gave indications of a body scent, and we saw a bear rise from his bed under a blow-down at the foot of a ledge 50 yards away. We tried to keep in touch with the chase during the afternoon and at nightfall we heard the dogs baying the bear on higher ground. Before we could reach them darkness fell and one of those sudden storms with high wind enveloped the mountain. Within a half hour five or six inches of snow fell. We had lost contact with the chase. The dogs could not find their way back to us with all sign and scent buried under heavy snow. We were in the midst of a blow-down of several thousand acres. We should have stayed where we were as it was impractical to travel in the down-timber at night, but we were wet and we had no axe. We made our way out and reached camp at 3:00 a.m. We had plenty of opportunity to look over the scene of this incident as we spent the following days in that vicinity hunting lost dogs.

The incident furnished convincing evidence regarding dormancy. This bear had unquestionably "holed up" in mild weather. His bed was made on top of the ground—not in a cave or a den. The fact that our dogs had found no trail in that vicinity during several preceding days would indicate that the bear had not moved during that time. He was aroused by our voices, not by our scent as we were down wind of him; and not by the dogs as they were beside us and did not give tongue until they struck his trail a moment later. The fact that snow fell during this incident would suggest that the bear had chosen his bed on top of ground with indifference to the early prospect of snow and cold. As the dogs could not hold him at bay nor drive him out of the down-timber during a chase

of several hours, he evidently sensed the security of his chosen cover. His bed was on a southeasterly exposure.

Association with bear hunters in several states over a period of 30 years has afforded much opportunity to learn opinions and beliefs regarding the ways of bears, and I have been especially interested in those concerning dormancy. The belief that bears "hibernate" to escape cold weather is almost universal. Shortage of food, during winter, is held by some to compel "hibernation." Many believe that bears seek a hole or cave at the approach of cold weather into which they retire for the winter. Some go further and testify that the opening to such a den is closed by the bear to keep out the cold. Others are convinced that the winter sleeping places are chosen on a northerly exposure where the bears will not be wakened, by the rising temperature of spring, until vegetation has sprouted on southern exposures and lower altitudes. Some believe that dormant bears are nourished by "sucking their paws" or that they "live on their fat" and emerge in spring "thin and hungry." Behavior that does not conform is generally dismissed with the remark, "Well, you can never tell what a bear will do."

Having known these friends for years I have ventured to question their offhand statements by reminding them of incidents in our mutual experience that did not support their opinions, such as following (on snowshoes) bears found traveling in the deep snow and low temperature of mid-winter; finding bears asleep whose black coat, in contrast with the snow, attracted attention from a distance; bears passing on snow within scenting distance of dead deer known to be in the vicinity (suggesting that they had been aroused by some unknown cause but were not seeking food); tracking bears into brush-piles and poking them out with sticks; dormant bears routed from beds on bare ground in mild weather; bears killed in late winter that were fat, although not feeding, and others killed in May that were fat although feeding indifferently on grass and buds. Any one of these incidents taken from the experience of any one hunter might be interpreted in various ways or dismissed as unusual or exceptional. But when taken from the experiences of many hunters, over a wide range of territory, time and conditions, and considered in relation to a central idea, they fit into a pattern that explains the seemingly inconsistent actions of bears. The central idea is the proposed theory that bears become dormant due to a surfeit of food.

The following incidents are related to show the conditions of bears in so-called hibernation:

Attracted by a mound of freshly dug earth, the observer approached and found a pit two or three feet deep occupied by a sleeping bear. He withdrew quietly and returned with several companions who formed an interested circle around the pit. One of the men tossed pebbles at the bear, which moved slightly but not not waken. The bear was then poked with a stick. He rose and placed his front feet on the rim of the pit, yawned and opened his eyes, blinking in the bright light. Instantly sensing the situation, he left the spot at high speed. This bed was located on the level ground of a ridge-top. The incident occurred in late fall while food was available. There was no snow and the ground was not frozen.

In preparation for a log drive several men approached a skidway on the bank of a northern river to roll the logs into the stream. One of the men noticed a movement of the snow covering a brush-pile nearby and called the attention of his companions. A large bear emerged from the brush-pile, shook the snow from his coat and moved leisurely away. This occurred on level ground, equally exposed in all directions, and at low altitude within 30 miles of tidewater.

The finding of dormant bears is not common. With few exceptions (within my knowledge) the bears thus discovered were partly or wholly exposed to the weather from above. I have never had positive knowledge of a dormant bear found in a cave or den, that is, completely hidden underground. That may be due to the fact that a bear thus denned would seldom be found unless tracked in on snow. The nature of bears leads one to believe they prefer a sleeping place well secluded from discovery, but from which they are not hampered by their surroundings in making a quick get-away in any direction if disturbed. The exceptions mentioned were bears found in old buildings (abandoned lumber camps and barns in remote districts and, in one case, an old pig pen). In each case the bear had torn up a portion of the old floor and had dug into the earth to make his bed. Other exceptions to the wholly exposed nest have been those under up-turned roots and under the overhang of ledges or large rocks, where the bear was but partially exposed.

Dormant females found with young (those of which I have had positive knowledge) have been in what might be called open nests, that is, not completely underground as would be the case in a den or cave. These beds or nests were sheltered by upturned roots or rocks, but were partially or wholly exposed to the weather from above. Females disturbed in their winter quarters are known to leave their cubs, sometimes carrying one away in their mouth, as the cubs are helpless at that time. In one case a Conservation Officer rescued two badly chilled cubs that had been abandoned. When the mother did not return, he was obliged to warm the cubs inside of his shirt while carrying them to his home. (They revived and were brought up on a bottle.) In another case the mother bear was disturbed by blasting and abandoned her cub in the nest. She may have taken a second cub with her. Her presence in the vicinity was not known until later. Her tracks in snow showed that she had left in a great hurry. She did not return to the nest and the abandoned cub was dead when found. Other cases of abandoned cubs have been noted, both during and after the dormant period.

Although efforts have been made, I do not know of a successful attempt to take the temperature and pulse of a wild dormant bear. The fact that falling snow vanishes from the back of a dormant bear at low temperature indicates that their body temperature does not fall to a great extent. Their indifference to cold would certainly equal that of deer, foxes, wolves, lynx, rabbits, and dogs which commonly sleep in snow without protection. The animal heat of large bears, which have been hog-dressed and left lying in snow, is dissipated very slowly.

If the oxidation of fat depends on the intake of air, the slight loss of weight

during dormancy would be explained by the slow rate of respiration. This rate has been noted by a reliable observer as low as five inspirations in two minutes. The average reported seems to be four or five per minute. The low rate is understandable when we consider that volume of intake is the essential quantity. The breathing of men in normal sleep is but slightly faster, and that of some mammals, under certain conditions, is slower.

SUMMARY

The definition of hibernation specifies a "torpid" state. Torpid is defined as, "having lost, partially or wholly, sensibility or the power of motion" (which is commonly understood as implying a state from which the animal can be aroused with difficulty). Dormant is defined as, "a state resembling sleep, that is, not easily aroused to action although capable of it."

The condition of bears during their long sleep might be described as dormant, rather than torpid, in the sense that they are rather easily aroused to action.

The accumulation of fat by bears seems to be an instinctive preparation for a period of food scarcity. If the accumulation is not sufficient, the activity of the bear may, and frequently does, continue during winter. When sufficient fat has been accumulated, the black bear ordinarily retires, without regard for temperature, to a secluded place and becomes dormant.

The location of the winter sleeping place is a matter of indifference to the bear as long as it is secluded and on ground that is well drained. The location of the bed often suggests conscious provision for protection against prevailing winds.

Due to a decreased rate of metabolism, a fat bear shows slight loss of weight during the dormant period. Following the dormant period their renewed activity rapidly depletes the store of fat while the animal is on a deficient diet (as in spring on a diet of grass). The fat continues to decrease until fattening foods are again available in quantity.

The shrinking of the digestive organs seems to mark the end of the bear's interest in food, and the beginning of his desire for seclusion and sleep. The shrunken and semi-rigid condition of the stomach *appears* to make the taking of food impossible. Here is a matter for the scientist to decide: Does the bear stop eating because of his shrunken stomach? or Does his stomach shrink because he stops eating?

"Seeing is believing" and it is natural for us to be skeptical of statements regarding things seldom seen. The facts of dormancy in bears are attainable principally at a time when but few of us venture from the open road. It is far easier to contrive an answer to the questions of dormancy in the comfort of the fireside by the "two-plus-two-method" than to find them in remote districts on snow shoes. But anyone who will follow a mid-winter bear track to its end will find the key to the answer in the stomach of the bear.

Perry, New York.

MAMMALS OF THE KNIK RIVER VALLEY, ALASKA

CHARLES G. WILBER

During the year 1943–44, the author was in charge of a military unit stationed in Alaska. Routine training and testing missions brought the unit into the Knik River Valley often and for long periods of time and during these maneuvers it was possible to study much of the plant and animal life of the region.

The Knik River is a typical glacier river fed by the Knik Glacier (Pl. 1, upper), which is about three miles wide at the foot. During the summer months (June to early September), the river is loaded with fine gray silt; during the winter the water is crystal clear. The Valley itself is about five miles wide near the foot of the glacier and gradually widens until it merges with the Matanuska Valley (Pl. 1, lower). The Knik River carries its water into Knik Arm an extension of Cook Inlet. Small mountain streams add their water to the main body of the river. The Valley is heavily forested with spruce, cottonwood, alder, and low brush from the lower mountain slopes to the banks of the river.

Not far from the region under consideration is the famous Matanuska agricultural settlement in the lower part of the Matanuska Valley. About 40 miles away is a good-sized town, Anchorage. The Knik Valley is unsettled but is readily accessible by road. Its location makes it ideal for recreational purposes. As the Matanuska settlement and the city of Anchorage increase in size, more and more sportsmen will be drawn to the Knik Valley. Consequently, in all probability there will be a change from the present large and varied mammalian population. It should prove interesting to ascertain the changes which may take place in the coming years as a result of increased use of the valley by sportsmen and "outers."

Most of the information concerning the mammals listed below was collected personally by the author. Unless otherwise stated no mammal was reported unless it was seen alive. In several instances recently taken pelts were accepted as evidence of the presence of a particular species. Relative frequency of the various species was ascertained from trappers' reports and from personal observation. Over a period of twelve months a fairly good idea of the population was obtained. It was impossible, under the conditions obtaining at the time, to make a permanent collection of the mammals of that area.

ACCOUNTS OF SPECIES

Ursus americanus. Black Bear.—The black bear was common. Numerous individuals were seen, usually on the lower slopes of the mountains. In the early spring of 1944, the tracks of adults and cubs were numerous in the wooded lowlands of the valley. It was observed that the bears fed extensively on the serviceberry which occurred widely. They usually avoided our camps, but tracks indicated that they had on many occasions detoured around us during the night. None of our caches (even relatively unprotected ones) were disturbed by bears. A trapper's cabin, however, showed evidence of complete ransacking by a bear.

PLATE 1

UPPER: Photograph of the Knik River valley looking toward the Glacier from a point on the right bank of the river about fifteen miles downstream from the Glacier. The river was frozen over solidly when this picture was taken.

LOWER: Map of the Knik River Valley, showing its confluence with the Matanuska Valley; also, the Matanuska agricultural settlement.

Ursus horribilis. Grizzly Bear.—Tracks of this bear were seen several times about a mile from the glacier. Several trappers reported that they had seen a few and one told us that he had shot one of the beasts recently; however, he had no pelt to show us.

Martes americana. Marten.—One of this species was seen deep in a spruce forest. It was extremely timid and soon scooted from sight. A pelt, examined later, was typical for the Alaska marten. Several trappers in that area reported that the martens were not at all plentiful. Most of them were in the spruce woods near the glacier.

Mustela rixosa. Pygmy Weasel.—One of these little animals had its home beneath a dead cottonwood log near one of our base camps. When we broke into its hiding place, we found the partially devoured skulls of several rabbits which we had recently cleaned. The animal's movements were unbelievably rapid. Several times we attempted to capture it, but were astounded at its ability to disappear instantly and reappear at some remote spot. Several were seen throughout the year 1943–44; during the winter its tracks were common. It was the only species of weasel that we saw. A trapper, however, told us that he had caught weasels that were much larger than those we saw, but he had no pelts to show us. The larger species may have been *M. erminea*.

Mustela vison. Mink.—Several beautiful pelts of this species were shown to us by a trapper who took them in the winter of 1943–44. He said that they were moderately common but that they had not been plentiful for years. We saw none of the animals alive.

Lutra canadensis. Otter.—One individual was seen. It had been caught in a trap near a small lake on the right bank of the river. The pelt was a rich dark brown above and slightly lighter on the underside. No live otters were seen. The trapper who took the pelt told us that the species was quite rare in the valley.

Gulo luscus. Wolverine.—Only one of these animals was seen and that at a distance through field glasses. It was very dark and apparently had no gray or brown markings. Their tracks, however, were numerous in the area. The results of their depradations were evident at several food caches that we had not arranged with sufficient care. Several trappers in that region told us of instances of food thievery and destruction by "the devil dog". The wolverines never came near our camps while anyone was there. Usually we could leave a camp or cache unguarded for three or four days with impunity. After that time, however, some wolverine would wander in and ransack the area.

Vulpes alascensis. Red Fox.—This is a large species of fox with fine general appearance. It is not very common in the valley, although a few recent pelts were seen. A trapper told us that the number of red foxes had been decreasing during the past 5 or 10 years. Previous to that time they were said to be common.

Canis latrans. Coyote.—Early one morning in January 1944, a coyote was seen slinking across the glacier flats toward the left bank of the river. It progressed with a peculiar "tail-between-the-legs" motion. Several shots were fired at it, but apparently it did not hear them, for it continued on its way with no change of speed or direction. Tracks of this species were seen fairly often, especially in the snow around rabbit runways. In the early morning their yelping was a familiar sound. However, they usually remained at least one-half mile from any of our camps.

Canis lupus. Gray Wolf.—During the winter of 1943–44 there were numerous wolves in this area. Local trappers told us that it was the best wolf season in several years. Most of the animals were traveling in groups of 3 to 6 individuals. At no time during the period in question were groups of more than 6 individuals encountered. The wolves were cautious and avoided coming close to us whether we were alone or in small groups. An old time trapper in the region told us of an especially large, almost completely black, specimen which he described as being "as large as a small black bear." Several wolves which we saw from a distance were unusually large. The tracks which we observed indicated that they were definitely larger than wolves encountered in the States.

Lynx canadensis. Canada Lynx.—No live lynx were seen, but a trapper had several pelts taken in the early winter of 1943–44. We found no tracks of the animals nor did we have any evidence of their presence other than the aforementioned pelts.

sides and a canvas sleeve on the sixth, through which the bats and their food and water dishes may be handled. The cages are arranged in rows in one of the rooms of the animal house which is an open screened structure with a galvanized iron roof. Thus the bats are subject to the local temperature and humidity conditions, but sheltered from sun and rain. Each afternoon a stender dish of defibrinated beef blood, secured from a local slaughter house, is placed in each cage, along with a dish of water. Blood and water are changed daily. The

TABLE 1.—*Desmodus rotundus murinus living more than five years in captivity at the Gorgas Memorial Laboratory*

BAT NO.	SEX	TIME IN CAPTIVITY		
		Years	Months	Days
30	♂	12	9	—
51	♂	11	2	4
73	♂	10	6	—
36	—	9	5	25
177*	♂	9	1	4
77	♂	8	11	27
170	♂	8	10	7
98	♀	8	9	2
181	♂	8	1	22
254	♀	7	9	19
178*	♀	7	6	18
101	♀	7	1	26
70	♂	7	—	—
76	♀	6	11	2
62	—	6	10	16
83	♀	6	6	17
253	♀	6	6	6
95	♂	6	5	18
91	♀	6	4	2
249	♀	6	1	1
190	♂	±6	—	—
119	♀	5	4	18
140	♀	5	3	11
116	♀	5	1	26
125	♀	5	1	6
126	♀	5	0	25
32	♂	5	0	1

* Immature at time of capture.

routine feeding activities of these bats in captivity have already been described by Ditmars and Greenhall (1935).

In view of the paucity of information on the longevity of bats, the records of the *Desmodus* kept at the Gorgas Memorial Laboratory are of particular interest. The banding of bats will, over a period of years, provide an excellent source of information on this point. We already have recovered vespertilionid bats (*Myotis l. lucifugus*) banded some five years previous. Donald Griffin has

informed me in correspondence that he has made recoveries considerably exceeding this period. For the Desmodidae there is the record of Bridges (1943) of a specimen of *Desmodus rotundus murinus* surviving for 6 years 3 months and 17 days at the New York Zoological Park. He also lists six other individuals that were held in captivity for more than one year. In Table I are listed those bats of the Gorgas Memorial Laboratory Colony that survived five years or more. The ages of these bats at the time of capture is unfortunately not known, beyond the fact that they were adults at the time of capture, with the exception of numbers 177 and 178 which were immature.

In four cases the exact date of death is not recorded, and it is unfortunate that one of these four should be that with the longest record in captivity. This bat was taken on Taboga Island on September 7, 1932, and died in June 1945, after 12 years and 9 months in captivity. A review of the sex of these long lived bats presents a point of interest. Of the eight bats with the sex recorded, which lived for more than 8 years in captivity, seven were males. There is thus some indication that the males may be longer lived than females.

The fact that only 27 out of a population of 261 vampires lived for more than 5 years in captivity is not particularly significant, since the colony was not maintained with a longevity study in mind. Specimens were sacrificed in various experiments concerned with the transmission studies of *Trypanosoma hippicum*. Furthermore it is reasonable to assume that of the random sample caught, a significant proportion were elderly individuals that had lived the greater part of their life span.

Early in the history of the colony several young were born when males and females were kept in screened horse stalls about 10′x10′x10′ at the Miraflores Veterinary Station of the Gorgas Memorial Laboratory. Among the bats confined in the 18″ square cages in the Laboratory animal house no births were recorded until recently. In 1943 and 1944 five individuals were born. Since even in such a confined state matings and births occurred, it is reasonable to suppose that under good conditions it would be possible to maintain a colony of *Desmodus* indefinitely.

In recent years the *Desmodus* colony has received little attention since no active investigations involving these bats have been in progress. The refrigerated defibrinated blood stocks were held for considerable periods and may have, on occasion, spoiled. In any event the most recent additions to the colony (other than by births) were made in September 1937, and the last surviving bats finally perished in June 1945, so that the colony is no longer extant.

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Gorgas Memorial Laboratory, Panama, Republica de Panama.

TRAPPING THE CALIFORNIA GROUND SQUIRREL

By Everett E. Horn and Henry S. Fitch

The California ground squirrel (*Citellus beecheyi*), with its various geographic representatives, has gained a reputation with those who have tried to control it as one of the most sagacious and adaptable of rodent species. Its adaptability, combined with its wide geographic range, high reproductive potential, destructive habits, and its role as a carrier of disease transmissable to man, renders it one of the most serious pests to agriculture and public health in parts of our western states.

During the years 1935 to 1942 inclusive, in the course of ecological studies on this ground squirrel and its relationship to forage plants at the San Joaquin Experimental Range in the Sierra Nevada foothills of Madera County, California, we had extensive experience in live-trapping, baiting, and poisoning. This work was carried on in collaboration with the California Forest and Range Experiment Station. Also, each of us has had experience with the same species in various other localities where, in some instances, our observations contrasted with those made at the Experimental Range.

Numerous devices for catching the squirrels alive were tried but mostly with little success. In general, this squirrel is shy of traps and it was only after a long process of trial and error that a box trap model specially adapted to its psychological peculiarities was achieved, with which a trapper was sometimes able to secure 60 or more squirrels in the course of a day.

In the early stages of our work many squirrels were obtained by use of padded steel traps, usually size no. 0, but this was an exceedingly inefficient method of capturing them. They were wary in detecting and avoiding even well concealed traps. Squirrels usually inhabited extensive burrow systems, or warrens, having 20 or more entrances, usually intercommunicating underground, and they merely avoided entrances in which traps were placed. When a trap was set at every entrance, the squirrels still avoided them, either by digging new short side passages to the surface, or by edging around the traps in certain large holes in which space was sufficient. In one such instance in which a set was made at every hole, the squirrel, an adult male, apparently did not emerge at all for five days; it was then caught as it attempted to escape from one of the larger burrows.

Better success was obtained when traps were concealed at a distance from the burrows in runways or in damp earth beneath overhanging creek banks in shaded spots to which the squirrels habitually resorted during the heat of the day. Squirrels were less acute in detecting traps in such situations than in finding and avoiding those set in the immediate vicinity of their burrows. When traps were "blind set," that is when trap, chain and stake were completely covered with finely sifted earth, sets were most successful, but any evident disturbance of the soil was apt to be carefully inspected by the squirrels. One would approach a concealed trap cautiously, with slow, stalking gait, and might leap over it or sidle around it. Often loose earth was dug away by a squirrel from the edge of a concealed trap exposing one jaw, and sometimes the loose jaw on the side not

held down by the trigger was flipped over, rendering it harmless. Such behavior was indeed remarkable in a rodent that could not have had experience with any kind of trap previously. Small young, newly emerged from their burrows, were just as hard to trap as were the adults, demonstrating that the usual cautious behavior toward traps was instinctive and not learned.

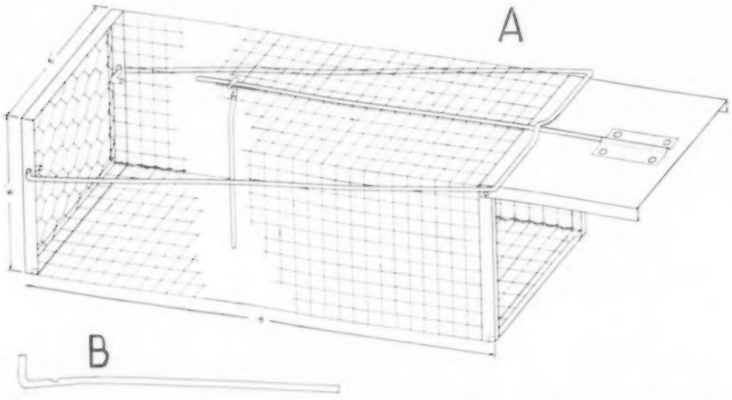
In trapping the northern representative of the species, *Citellus beecheyi douglasii* in various parts of Oregon, we have both had excellent success with unconcealed steel traps set in burrow entrances, and have found this squirrel to be notably lacking in the caution for traps which render its relatives of the California coast and Sierra Nevada foothills so difficult to catch.

On the Range, substantial mortality to ground squirrels is caused by rattlesnakes, which appear to be among the most destructive natural enemies. Many encounters between squirrels and snakes were observed and the squirrels were obviously on the alert almost constantly to detect such ground lurking predators. On several occasions when a snake was observed striking, the squirrel had been momentarily frightened and put off guard by the approach of a human. When among rocks or dense vegetation where snakes might be concealed, squirrels were observed usually to proceed slowly with much caution, tensely examining their surroundings at each step. Possibly the wariness of the southern subspecies of ground squirrels in avoiding concealed traps may be in some measure conditioned by their racial experience with lurking snakes.

Snaring of squirrels with fine copper wire set in runways or burrow entrances was also given an extensive trial. Although those caught often escaped by snapping the wire, and mortality was high, it was found that the squirrels readily blundered into the wire nooses and did not detect or avoid them skillfully as they did traps on the ground. The many kinds of box traps tried could not be thoroughly concealed or camouflaged and the squirrels always approached them circumspectively at first encounters. Obviously attracted by the bait, squirrels were often seen to linger in the vicinity of such traps or return to them repeatedly to clean up bait scattered outside without entering. Usually box traps had to be left in position several days to familiarize them to the squirrels before a good catch could be expected. In those traps having a treadle mechanism for tripping, squirrels often avoided the treadle, moving up to or edging around it to take the bait.

A successful live squirrel trap finally designed, embraced these psychological traits (figs. 1 and 2). The release mechanism consists of a pendulous trigger which the squirrel sets off by touching with its sides or head as it reaches for the bait beneath or behind. No tendency to avoid these hanging triggers was noticed. The trap is constructed of half-inch mesh galvanized wire "hardware cloth" and is 6″ x 6″ x 18″. The back end is of inch mesh wire soldered or welded to the body. The front end or door, is of solid metal, hinged or pivoted to the body of the trap along its upper edge, and heavy enough to swing down sharply when the trap is sprung. A light metal rod fits into a socket on the upper side of the door, and, when the door is opened to a horizontal position, this rod lies back along the top of the trap to be engaged by the upper horizontal end of

the trigger. A lower notch engages the wire top of the trap, holding the trigger in place. The mechanism serving to lock the door is a heavy wire bail, pivoted in the back of the trap and held up by the door while the trap is set. When the door falls, the bail drops over it holding it closed.



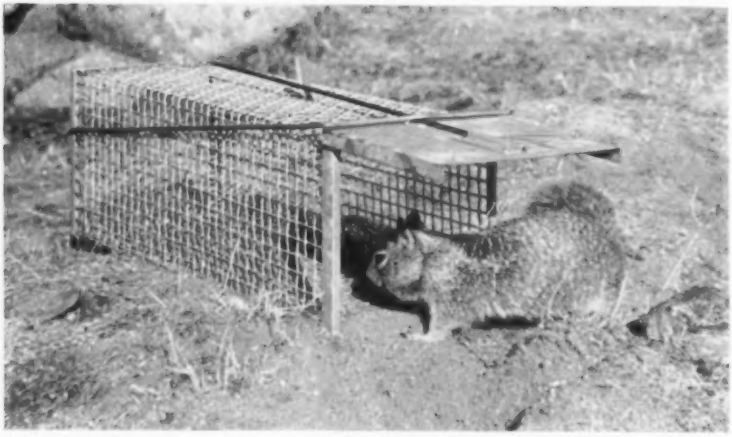


FIG. 1 (upper). A. Diagram of ground squirrel trap showing its construction. B. Design of trigger.

FIG. 2 (lower). Ground squirrel entering trap.

Usually the traps were set on the burrow mounds, and the wire bottoms worked into the loose soil there so that the metal was entirely concealed. The triggers hang with their lower ends only an inch or less over the bait and are so sensitive, that they may be tripped by mice, small birds, or even a breeze. After pro-

longed live-trapping and releasing of squirrels on a study area, they were somewhat easier to catch than those on adjacent previously untrapped areas. This change involved cultivation of a fondness for the baits used, and familiarization with the traps, which were no longer regarded with as much suspicion as at first. As compared with mice, rabbits, and some other mammals, squirrels showed less tendency to become persistent repeaters and only a few crippled or otherwise handicapped individuals became so addicted to traps as to return soon after being released. Although somewhat easier to catch after having been once trapped, they always showed some caution in approaching traps. Squirrels were not wary of traps by seeing another individual caught; even as the trapped one struggled and scolded, attempting to escape, another might try to gain entrance into the same trap to secure bait still remaining there.

Acceptance by the squirrels of various kinds of bait were tested at the Range under conditions designed to show their preferences. Several kinds were tried together at each test, and were either mixed or arranged in patterns so that any selection was evident. At times results were somewhat contradictory indicating that individuals may differ somewhat. Prunes, nuts, sunflower seeds, and acorns are all relatively poor baits as compared with grains. Rice was scarcely taken. Breakfast rolled oats and rolled barely were taken sparingly. Whole grains were much preferred, both at the Range and at many other points throughout California. Wheat usually seemed to be the preferred grain on the Range, although this preference was local and not general throughout the State. Whole barley was taken almost as well, but has proven a choice bait elsewhere throughout the State for many years. In most tests milo was less readily eaten than these other grains, but was preferred to rolled barley, breakfast rolled oats, or baits other than grains. Squirrels on most parts of the San Joaquin Experimental Range have not been subjected to attempts at control through the use of poisoned grains, and this may have considerable bearing on the order of preference shown for various food items as contrasted to the situation in populations long subject to control. In routine trapping, a satisfactory mixture of equal parts of wheat and milo was used, partly for the reason of easy avaiability. No clear cut changes in order of preference of the best baits from one time of year to another were apparent. But the acceptance of grain bait in general, in relation to natural foods, changes strikingly from one season to another.

Squirrel activity at the Range increases during the winter until in February all have emerged from dormancy, and at this time grain bait is taken well. Acceptance continues high through the early part of March while the squirrels are feeding mainly on foliage of new vegetation. In late March or early April the diet changes to ripening filaree seeds, then successively to many other kinds of seeds, flowers, and fruits as each species of plant attains the preferred stage of maturity. During this spring season squirrels are gaining weight rapidly and with little effort are able to find many kinds of natural foods of specially preferred and nutritious types. Consequently grain baits are then much less attractive to them than at other times of year. Each year as this stage of the annual feeding cycle arrived, the daily catch of squirrels suddenly decreased by

more than half. In squirrel populations previously unbaited and not having acquired a taste for grain, even poorer acceptance might be expected.

SUMMARY

California ground squirrels were found to be wary of all kinds of traps; even blind set steel traps are usually detected and avoided. The squirrels' habit of moving cautiously, with alert inspection of the surrounding ground for snakes and other enemies, makes them difficult to catch. A wire box trap with a sensitive pendulous trigger was far more successful than any of the other devices tried. Grain baits were most attractive to the squirrels; of those tried wheat and whole barley were preferred. Bait acceptance is poor during a period of weeks in late spring when many kinds of food plants on the range are maturing.

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THE WING BANDING METHOD IN THE STUDY OF THE TRAVELS OF BATS

By Harold Trapido and Peter E. Crowe[1]

In recent years there has been aroused among mammalogists a considerable interest in the study of the travels of bats in eastern North America. Two methods of marking bats for later recognition have been employed—ear tags similar to the fingerling tags used on fishes (Mohr 1934) and bird bands of the Fish and Wildlife Service around the legs (Griffin 1940).

In the past five years, we, together with William A. Wimsatt who has been our constant companion on bat collecting trips, have banded approximately 5000 bats employing yet another method. While we are not yet prepared to present the results of our work on the movement of northeastern cave bats, this preliminary report on the technique of wing banding has seemed advisable due to the increasing interest in the subject.

There are two principal disadvantages to the method of leg banding employed by Griffin. As Griffin (1945) points out, the bands become overgrown with flesh and it becomes difficult or impossible to read the numbers. Secondly, in attempting to make recoveries of banded bats in the dense clusters characteristic of cave hibernating bats, leg bands may only be found after the clusters of bats have been taken down and individually examined. In caves supporting populations of thousands of bats this is an unnecessarily lengthy and tedious procedure.

The ear tags employed by Mohr are expensive and must be privately prepared to order.

In our studies over the past six years we have used the bird bands of the U. S. Fish and Wildlife Service but placed them around the distal portion of the forearm. We have worked principally with the little brown bat, *Myotis l. lucifugus*, and found bird bands of size number 0 to be satisfactory. The

[1] 1st Lieutenant, Air Corps, A.U.S., Deceased.

membrane from the shoulder to the forearm is so narrow near the wrist that the bands may be slipped around the forearm without interfering with this membrane. Bands thus located are in position beside the head of the bat when it is

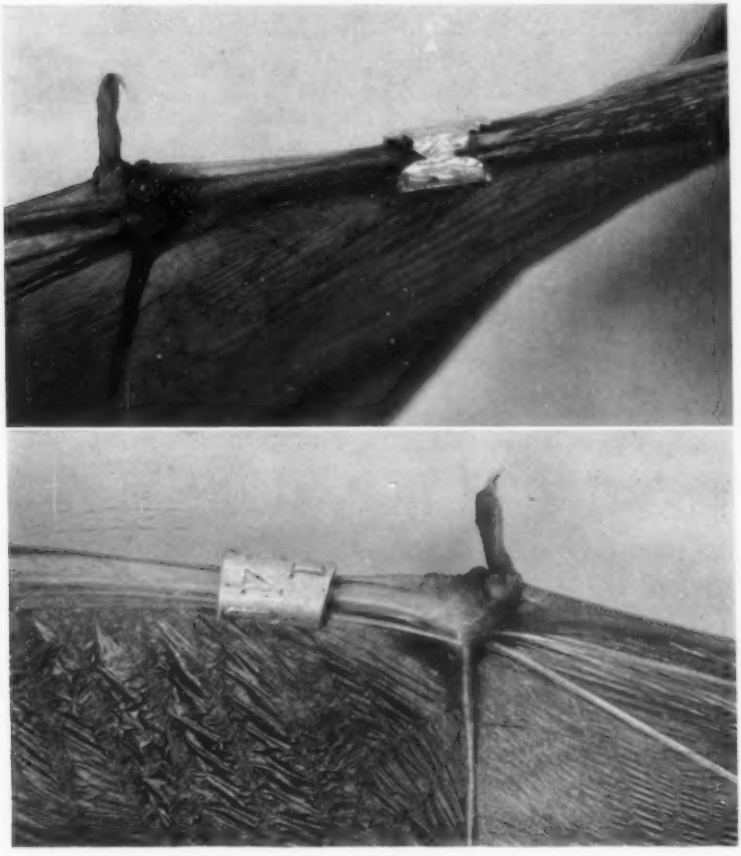

PLATE 1

The little brown bat (*Myotis l. lucifugus*) showing the results of improperly and properly placed wing bands after 4½ years. UPPER: The band in this photograph was pinched tightly around the forearm. The bat has almost completely chewed through the aluminum band. LOWER: This band is free to slide along the forearm and has been wholly undisturbed by the bat. Photographs by A. L. Smith.

at rest. They may usually be readily perceived in the light of an electric torch or headlamp when glancing over clusters of bats in caves. When the clusters are densely massed all bands may not be apparent, but by stirring the bats

slightly they usually move sufficiently to show any that may be wearing wing bands.

Since this technique may have wide application in the future there is one precaution which should be mentioned to avoid a difficulty we have encountered. It was our ordinary procedure to pinch the bands tightly together on either side of the wing membrane, so that the bands would not be free to slide along the forearm. The bands were of sufficient diameter so that no pressure on the bones of the forearm or the blood vessels along them was apparent. Nevertheless we have encountered not only an overgrowth of flesh about the bands, but also in some instances they are chewed so that the numbers are no longer legible. It is apparent that the bands pinched together on the wing membrane produce sufficient discomfort so that the bats often attempt to chew the bands loose. An extreme case of this sort is shown in Plate 1, upper, a marked bat recovered 4½ years after banding.

In the case of some of the bats the bands were inadvertently not closed with sufficient force to secure a grip on the wing membrane. We have found to our surprise that these bands while they are free to slide along the forearm seem to cause no discomfort, and bats thus banded make no attempt to chew the bands. Such bands are found to be without so much as a scratch after several years. Plate 1, lower, illustrates such a band in place after 4½ years. It would seem that the wing motion of the bats in flight tends, by centrifugal force, to keep the band in the most distal position on the forearm and the flight is not impaired by the loosely clasped band. In the wing banding of bats it is therefore indicated that the bands should be closed around the forearm so as to encompass the bones, but leaving a sufficient aperture to permit the band to slide freely along the forearm without pinching the wing membrane.

That wing bands might seriously impair the flight of bats is a matter we have considered and rejected since we have recovered bats banded by this method after five years and after performing flights upward of 200 miles from the point of release.

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Gorgas Memorial Laboratory, Panama, Republica de Panama.

MAMMALS IN ARCHEOLOGICAL COLLECTIONS FROM SOUTHWESTERN PENNSYLVANIA

By Raymond M. Gilmore[1]

In February 1942, Dr. C. E. Schaeffer of the Pennsylvania Historical and Museum Commission sent to the Smithsonian Institution for identification a large collection of animal bones from archeological excavations. These bones have been identified as far as possible. Mammal bones make up about 90 percent of the material, and because some species are of special interest, this account is written to supplement information in a forthcoming archeological report, and to make the zoological facts available to mammalogists.

Dr. C. E. Schaeffer has kindly submitted the following account of the history of the investigations and a description of the sites at Fort Hill, Martin, and Phillips (see map):

The faunal remains reported in this paper represent material recovered by the Pennsylvania Historical and Museum Commission from three archaeological sites in southwestern Pennsylvania. Fort Hill, the first to be explored, was one of a number investigated by local W. P. A. projects during the period 1934–40. Advisory assistance was provided by the Historical Commission in the services of Donald A. Cadzow, State Anthropologist. A preliminary report on the archaeological finds at Fort Hill appeared in the *Pennsylvania Archaeologist*, vol. X, no. 3, 1940. The other two sites, Martin and Phillips, were salvaged by the Historical Commission from threatened destruction by flood control-highway construction activities during the summer of 1941. The conservation program was carried out under the supervision of Dr. Claude E. Schaeffer, Assistant State Anthropologist. Francis M. Cresson, graduate archaeologist, directed excavations in the field, and is at present preparing an extensive study on the unreported sites in this area.

The three sites are located in the "hill country" of the Allegheny Plateau. The area surrounding the Martin site and Fort Hill constitutes some of the most rugged terrain in southwestern Pennsylvania. The former is situated on the Youghiogheny River: the latter near an affluent of that stream. Fort Hill, perhaps the most picturesque setting for a prehistoric Indian village in the entire state, lies in Addison Township, Somerset County, about four miles east of the town of Confluence. The "Hill," an isolated, mesa-like elevation, with precipitous slopes on three sides, rises to a height of 500 feet above the Casselman River, which circles it about a mile from the base. The summit is nearly flat and is estimated to include an area of about seven acres. On this hilltop location, the remains of two extensive, stockaded villages were identified, each containing some thirty-odd circular houses, with their attendant fire, storage and refuse pits, stone, bone and shell artifacts, pottery, human burials and faunal debris.

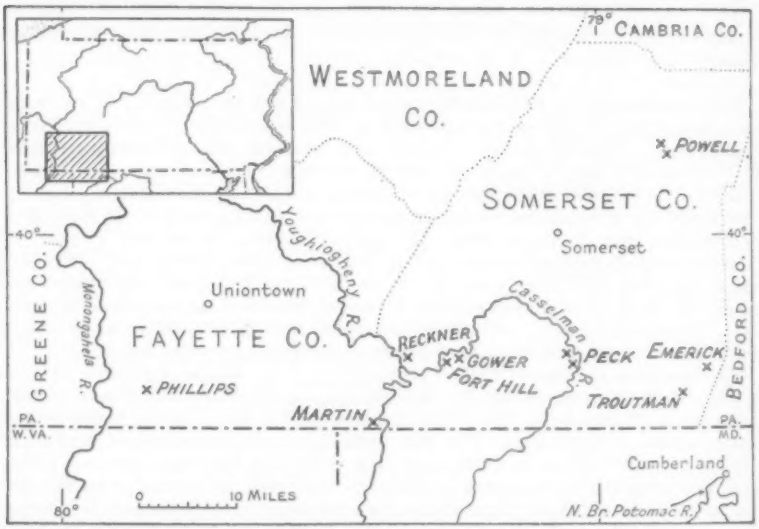
The Martin and Phillips sites are both in Fayette County. The former is in the hilly country of the extreme southeast corner of the county (Henry Clay Township). It is a flood-plain site located on the west bank of the Youghiogheny River, just north of Watsondale. The site is four miles south of Somerfield and about a half mile from the Maryland border. In this particular locality the topography is such as to confine the habitable land to the flood plain of the Youghiogheny, from which the valley walls rise steeply to elevations of several hundred feet.

In contrast, the Phillips site is in more open country. It is located upon a saddle joining two low-lying hills at Morris Crossroads (Springhill Township), immediately west of the

[1] Published by permission of the Secretary of the Smithsonian Institution, and the Pennsylvania Historical and Museum Commission.

main highway connecting Smithfield and Point Marion. The site is three miles east of the Monongahela River and one and one-half miles south of George's Creek. The house patterns and accompanying pottery and artifacts unearthed at both the Phillips and Martin sites resemble so closely those at Fort Hill, that all three are assumed to have been occupied by related peoples.

There is some evidence to indicate the presence in this area of the contemporary Alleghenian life zone [probably not Alleghenian, which is synonymous with Canadian, but rather Carolinian; see below] during the prehistoric occupational period. Charcoal remains recovered from archaeological debris at certain sites have been identified to reflect forest types characteristic of this life zone. The Phillips hilltop site exhibited oak (*Quercus* sp.), grape (*Vitis* sp.), and less certainly, hop hornbeam (*Ostrya virginiana*), and catalpa (*Catalpa* sp.). At the Martin site were found hickory (*Carya* sp.) and, less certainly, chestnut (*Castanea* sp.), ash (*Fraxinus* sp.), poplar (*Populus* sp.) and sassafras (*Sassafras variifolium*); specimens of bark represented a type of conifer, probably hemlock. Botanical identification was made by Dr. John S. Penny, University of Pennsylvania.



The southwestern Pennsylvania complex has been assigned, on the basis of typological and other considerations, to the Monongahela Aspect, a local manifestation of the widespread Woodland Pattern. Placement of these sites in the prehistoric period has been indicated by the absence therein of any European trade materials. On the other hand, they are not considered to be of any great antiquity. Demonstrable affinities with temporally-dated sites in adjacent states suggest the occupation of southwestern Pennsylvania well towards the close of the pre-contact period. In fact, Dr. T. Dale Stewart, U. S. National Museum, who has made a comparative study of the human physical types from this area, is inclined to advance the dating into the post-Columbian period on the basis of certain pathological evidence. So far, it has not been possible to determine any temporal seriation for sites in the Somerset-Fayette area.

The large number of animal remains from Fort Hill testifies to the large size of the site, and indicates long occupancy.

The Martin site is richer in animal remains even than the large one at Fort Hill. The greater number of species at Martin reflects the position of the site on a river bank of a precipitous river valley in hilly, wooded country. From the surface come all of the few remains of domesticated European mammals which were found. These may be post-occupation deposits.

The hilly and wooded nature of the country surrounding both the Fort Hill and Martin sites is shown by the preponderance of elk and bear remains found there. The ruffed grouse, a forest bird, is common at Fort Hill and Martin.

The Phillips site has a much poorer representation of animals. Perhaps this is due to its less favorable location and shorter occupancy.

The biotic province of the region probably is and was Carolinian hardwood and not Alleghenian conifer-hardwood (=Canadian; see Dice, 1943). This is corroborated by the absence from the sites of conifers and such typical Canadian mammals as the pine marten, fisher, red squirrel, and black porcupine. The remains of hemlock (*Tsuga*) are not significant in this connection because the species often occurs on the lower slopes of the mountains. There is no evidence that the biota or climate has changed noticeably in the last five centuries.

Preliminary to making the identification by direct comparison with known skeletal material, a list was made of all mammals that occur today in southwestern Pennsylvania (see Hamilton, 1943; Rhoads, 1903). The absence of certain of these mammals from the excavations is of interest, so these are included in this paper in a separate discussion (p. 232).

LIST OF SPECIES

American black bear (*Euarctos americanus*): 237 bone fragments (1.8 percent). The bear probably was an important food animal (almost as much so as the elk), and perhaps was hunted for sport and fur. Remains are predominantly from the Fort Hill and Martin sites, which is in accordance with the hilly and wooded nature of the surrounding country.

Raccoon, "coon" (*Procyon lotor*): 49 bone fragments. The coon probably was a common animal, especially from the country around the Fort Hill and Martin sites, where most of the remains were found. However, it was probably taken only occasionally for food, fur or as a pet.

Otter (*Lutra canadensis*): 2 bone fragments. The otter, though once common along the rivers of this region, is not easily captured, and many remains are not to be expected. Both specimens are from the river valley Martin site.

Skunk (*Mephitis mephitis*): 4 bone fragments. This is not significant, as the animal hardly was utilized in any special way and, in fact, probably was avoided as it is today.

Gray fox (*Urocyon cinereoargenteus*): 28 bone fragments. This species was common and apparently was the only fox in this region until the introduction of the European red fox (see p. 232). The gray fox has extended its range in the last 50 years (?) to include northern New York, Vermont, and New Hampshire, although it has become extinct recently in Maine (Hamilton, 1943, pp. 175–176). Its peripheral range obviously is unstable. It is primarily a southern and western animal. Most of the specimens are from the Martin site, which is not easily explainable. The Phillips site, with only 3 specimens, should have had more in accordance with the open nature of the surrounding country. Nor is there apparent any special utilization of the gray fox, aside from fur.

Wolf (*Canis lupus*): 1 bone fragment (part of lower jaw with teeth).

Dog (*Canis familiaris*): 181 bone fragments, including 17 parts of mandibles and maxillae with teeth. The bones indicate a dog of medium size, similar to that of a retriever or fox hound. The Martin site contained by far the largest number of fragments. Although the

number does not indicate many individuals, it is certain that dogs were plentiful and, as Schaeffer suggests, they may have been used for food, thus paralleling the condition among the Iroquois in New York state. The specimens are deposited with the U. S. National Museum in the Division of Mammals.

Wolf or dog: 3 bone fragments.

Bobcat, lynx (*Lynx rufus*): 6 bone fragments. These are probably adventitious, although the animal may have been sought for its fur.

Woodchuck, ground hog (*Marmota monax*): 62 bone fragments. This is not of special significance because the remains may include not only those of individuals killed by the Indians for food, but also those that have died a natural death in burrows in the mound after Indian occupancy. About 85 percent of the specimens come from the Martin site, which fact probably indicates more favorable conditions for the "chuck" at that locality.

Chipmunk (*Tamias striatus*): 313 bone fragments (2.36 percent). This is significant because of the large number of well-preserved bones. Probably these are remains of individuals that were semi-colonial inhabitants of the Indian village during or after human occupancy, and that died a natural death. Or the remains may represent individuals killed by Indian children and dogs and discarded, although in such case one would think that dogs might consume all such carcasses. It is doubtful that the Indians utilized the chipmunk for food. If the remains are those of naturally dead individuals, there is indication that when in a weak condition they return to their burrows to recover or die, or perhaps death from sudden cold "snaps" overtakes even normal individuals there. Most of the specimens come from the Martin site, followed closely by Fort Hill; Phillips had only 8 specimens. The forested nature of the country surrounding the former sites probably explains this.

Gray squirrel (*Sciurus carolinensis*): 133 bone fragments (1 percent). This species was probably a common food animal and an object of sport among the children, as it was many years later in colonial times to the white settlers. The remains are significant mainly in indicating a hardwood forest in the immediate vicinity of Fort Hill and Martin where most of the remains occur, and also in comparison with the absence of red squirrels and the scarcity of remains of fox squirrels.

Fox squirrel (*Sciurus niger*): 23 bone fragments. This may indicate a scarcity of this species in the region at that time, or it may be a measure of the difficulty in hunting them. The bones are distinguished from those of the gray squirrel by appreciably larger size, although it is admitted that small fox squirrels (not young with open epiphyses) can be confused with large gray squirrels. Most of the remains are from the Fort Hill site.

Beaver (*Castor canadensis*): 31 bone fragments, all sites about equally represented. Remains are less numerous than was anticipated, especially because the animal is large, colonial, tasty, and possesses a fine fur. Difficulty of capture may explain the scarcity of remains. The eastern beaver is extinct today, and as specimens of the original population are rare in museums, the best from these sites are deposited with the U. S. National Museum in the Division of Mammals.

Wood mouse, white-footed mouse (*Peromyscus* sp.?): 3 bone fragments. None is identifiable as to species (*maniculatus* or *leucopus*). The find is unimportant.

Cave rat (*Neotoma magister*): 15 bone fragments (1 from Phillips, 14 from Martin). The number is greater than was expected, and the large proportion from Martin indicates that the rocky cliffs on the precipitous valley walls of the Youghiogheny River near this site were ideal for the existence of the large cave rat. It was undoubtedly used for food, because adventitious remains of a species so closely restricted to a rocky habitat would not be expected to occur in a river-bank site. Absence of remains from Fort Hill is not easily explainable because suitable rocky cliffs should be present on the sides of the mesa there.

Marsh rat (*Oryzomys palustris*): 2 specimens, one a lower jaw from Fort Hill ("Topping") and the other the anterior half of a skull from Martin ("Pit 30"). These finds are interesting in that they extend the former range about 150 miles west from coastal Maryland to southwestern Pennsylvania. In coastal southern New Jersey, eastern Pennsylvania, Delaware, and Maryland, the marsh rat is found in brackish-water swamps only. Farther south, in

Virginia, North Carolina, to Florida, Mississippi and Tennessee, it is found also in more upland localities, but generally in wet grass and sedge habitats (Hamilton, 1943, p. 295; Schantz, 1943, p. 103). The specimen from Martin could be adventitious; that from Fort Hill mesa is undoubtedly the result of human or predator intervention. The two specimens are deposited with the U. S. National Museum in the Division of Mammals.

Meadow mouse (*Microtus pennsylvanicus*): 2 bone fragments. These are undoubtedly adventitious; the species is extremely common.

Muskrat (*Ondatra zibethica*): 8 bone fragments. More remains were expected because the animal is a good source of food and fur, and is generally common where it occurs. All specimens are, naturally enough, from the river-bank Martin site.

Varying hare, snowshoe rabbit (*Lepus americanus*): 11 bone fragments (1 from Martin, 10 from Fort Hill). Evidently these localities have been long on the peripheral range of this species. Although it extends far south in the Appalachian Mountains to Tennessee (Kellogg, 1939, p. 289), it is found more abundantly in coniferous forests of the Canadian biotic province, which seem to have been absent from the vicinity of the archeological sites, especially Phillips.

Cottontail rabbit (*Sylvilagus floridanus*): 32 bone fragments. Bones of this species are distinguished from varying hare by much smaller size when adult. Possibly the collection includes some bones of the Allegheny cottontail rabbit (*S. transitionalis*), but accurate identification of skeletal fragments would be difficult. Rabbits make up a smaller part of the normal aboriginal food supply in this region than I had expected, or else the disappearance of such bony remains may be attributed to the scavenger activities of the many dogs kept by the Indians.

White-tailed deer (*Odocoileus virginianus*): 2930 bone fragments (25.8 percent) were found, and there were probably many more. I am of the opinion that at least 75 percent of the unidentifiable fragments are deer. All three sites are well represented by deer remains. The deer was doubtless the staple meat-food of the Indians and certainly was very abundant. It was a large animal and seemingly more closely related to the large northern subspecies *borealis* than to the smaller southern form *virginianus*, which is generally considered to have ranged into southwestern Pennsylvania. The native white-tailed deer in Pennsylvania almost became extinct within the last 50 years, but today it is numerous once more, the increased population being the result of importation from other states and of wise conservation and hunting laws.

Elk, wapiti (*Cervus americanus*): 271 bone fragments (2 percent). This is the second most common food animal. Over 90 percent of the specimens are from the Fort Hill and Martin sites, which is probably a natural consequence of the woody, hilly nature of the country there. The remains indicate an animal slightly smaller than the western elk (skeletons from Wyoming for comparison), considering equal ages on the basis of epiphyseal closures. This was also the opinion of Bailey (1937, p. 188), but Rhoads (1903, p. 34) quoted a man who had hunted elk in Pennsylvania and the Rocky Mountains as saying that the elk in Pennsylvania are larger, males weighing as much as 1200 pounds. A horn base from the Fort Hill site is 21 cm in circumference below the burr, about the grasp of a large-handed man, and big for any elk. The extirpation of elk in Pennsylvania occurred in 1867; in the period 1855–60 in Somerset County (Rhoads, 1903, pp. 30, 45). Existing museum specimens of this eastern race (*C. c. canadensis*) are extremely rare; consequently, the best preserved fragments (teeth, etc.) from the Historical and Museum Commission's collection are deposited with the U. S. National Museum in the Division of Mammals.

Bison (*Bison bison*): 4 bone fragments. All specimens are from the Martin site, which may be a consequence of the precipitous terrain on the edge of the river valley that forced the bison to use the river valley for a "trail" or enabled the Indians to ambush the bison and drive them over the adjacent cliffs. Remains are not as common in the sites as might be expected because this region was formerly inhabited by numbers of bison. However, " 'I am sure of one thing, the buffalo disappeared from the Co. [Somerset] before the Indian was driven westward. I suppose it is approximately true that the buffalo must have left the Co.

some time preceding Braddock's defeat in 1755.'—R. Smith in a letter to Dr. H. D. Moore" (Rhoads, 1903, p. 51).

Cattle (*Bos taurus*): 3 bone fragments from the upper levels of the Martin site, and obviously post-Columbian. These specimens, together with that of the horse from the same site and level, may have been deposited adventitiously within the last century as a result of post-occupational settlement by whites.

Elk, bison, or cattle: 6 bone specimens from the Martin site.

Horse (*Equus caballus*): 1 tooth fragment; post-Columbian; surface of Martin site.

Unidentified: 8890 bone fragments. Probably 75 percent of these are deer, and most of the rest are those of elk or bear. All are finely comminuted.

MAMMALS LIVING IN THE REGION TODAY BUT NOT REPRESENTED IN THE MATERIAL

American opossum (*Didelphis virginiana*, or *D. marsupialis virginiana*, if it is conspecific with the Central and South American common opossum, as I believe after an examination of specimens in the American Museum of Natural History in New York and in the U. S. National Museum in Washington). No bones of this species were found, which indicates probable absence of the opossum from southwestern Pennsylvania in aboriginal times. Rhoads (1903, p. 9) stated that in Somerset County the opossum was " 'Becoming numerous near New Lexington in the last few years. . . . Ten or fifteen years ago there were none'—Moore". Although Rhoads failed to mention Fayette County, there is no evidence that the opossum was there in 1900. Seton (1929, vol. 4, p. 639) showed in a distribution map that southwestern and central Pennsylvania were not inhabited by opossums at the time he wrote.

The opossum is known to have extended its range northward and eastward in the northeastern United States in the last 200 years. Accurate records of its spread might render it a faunal time-marker in archeology because undoubtedly the Indians would have used the opossum as food wherever present, and its remains would be found in the refuse of the village sites. It is of an appropriate size (up to 11 pounds) and easy of capture, especially with dogs. Therefore the absence of opossum bones from extensive archeological sites should indicate absence of the animal from the region. On the other hand, the opossum is a southern animal and not especially well adapted to low temperatures. It freezes to death in very cold winters. Oscillations that correspond to large climatic cycles should occur in its northward limits, which might invalidate its use as a faunal time-marker for archeology, but so far there is no evidence of such cycles. The spread of range seems to have been fairly steady.

Two species of moles, six shrews, and nine bats are not represented; their absence is not significant.

The absence of the marten (*Martes americana*) is best explained by the distance of the sites from heavy coniferous forests.

The absence of the fisher (*Martes pennanti*) is also significant. Though it is generally less common than the marten, it is similarly an inhabitant of deep coniferous forests.

No bones referable to the three species of weasel, or to the mink, were found.

The absence of the red fox (*Vulpes "fulvus"*) is highly significant. There is strong evidence that the native American red fox did not range into the middle eastern United States from the north in aboriginal times, and that the present red fox of the central eastern states is a direct descendant of the European red fox (*Vulpes vulpes*), which was introduced between 1650 and 1750 from England for fox hunting. The case against the occurrence of a native red fox in the eastern United States was stated well by Rhoads (1903, p. 146–147) and the absence of any red fox remains from these southwestern Pennsylvania sites corroborates this view. Thus the red fox may be an important faunal time-marker for eastern archeology. Any alleged remains of red fox in archeological sites in the eastern United States should be scrutinized carefully. Fortunately, many skeletal characters distinguish this fox from the gray fox, which long has been an inhabitant of the eastern United States.

Vulpes fulvus was described by Desmarest (Mamm., vol. 1, p. 203, 1820) on the basis of a red fox skin of unknown provenance in the eastern United States and on Palisot de Beauvois' description of the skull of a gray fox from Virginia (Rhoads, 1903, p. 146, footnote). Though

the presence of a gray fox skull in the description does not invalidate the use of the name for a red fox because the description can be fixed upon the skin, this skin may be actually that of an introduced European red fox, in which case the name would become a synonym of *V. vulpes*. In addition, from an examination of red fox specimens from Europe and Alaska, it appears likely that all the red foxes of northern Europe, Asia and North America are conspecific. If this be true, the matter of introduction may have to be determined entirely on historical records and archeological material (or the lack of it).

Remains of the coyote (*Canis latrans*) are absent; the recent records of this animal from the eastern United States are probably those of introduced animals (Hamilton, 1943, p. 178).

No remains of the cougar (*Felis concolor*) were found. This may be significant, and indicate a natural or socially dictated reluctance of the Indian to hunt the animal because the early colonial records state that it was very common in this area in late aboriginal times.

The red squirrel (*Tamiasciurus hudsonicus*) is conspicuous by its absence. This indicates that a considerable distance separates the sites from coniferous forests of the Canadian biotic province.

Flying squirrels (*Glaucomys volans* and *G. sabrinus*), the pine mouse (*Pitymys pinetorum*), the lemming-mouse (*Synaptomys cooperi*), and jumping mice (*Zapus hudsonicus* and *Napeozapus insignis*) are not represented in the collection, although this fact is not significant. The lack of remains of the red-backed mouse (*Clethrionomys gapperi*), however, may indicate an absence of suitable habitats in coniferous forests nearby.

Remains of the black porcupine (*Erethizon dorsatum*) were not found, indicating absence from the region. This is somewhat unexpected even though the animal is absent from the region today (its range now extends south along the Appalachian Mountains to central Pennsylvania and includes an isolated mountain area in West Virginia). However, in colonial times, it ranged as far south as Tennessee along the higher parts of the mountains (Hamilton, 1943, p. 370; Kellogg, 1937, p. 471; and 1939, p. 289). The subsequent decrease in range can be attributed to excessive persecution by man. The indicated absence for many centuries from the site-localities in southwestern Pennsylvania probably can be attributed to the close association of the black porcupine with heavy coniferous forests, which doubtless did not occur near the sites. The absence of the marten, fisher, red squirrel, and red-backed mouse from the sites also corroborates this assumption.

SUMMARY

Of 13,293 mammal bone fragments, 4,403 were identified as belonging to 26 species, of which 2 (based on 4 bone fragments from upper levels) are post-Columbian introduced domesticated animals (cattle and horses).

The deer is the most important aboriginal food mammal, far surpassing the elk or bear; other mammals are relatively unimportant. (The turkey, and perhaps the box, snapping, and wood turtles, were also important.)

The absence of the opossum and especially the red fox is important; both apparently were absent in early colonial and pre-Columbian times. The opossum seems to have spread naturally into the area subsequently; the red fox is believed to have been introduced from England. Both therefore may be of importance as faunal time-markers for archeology.

The presence of the marsh rat constitutes a record of the former extent of its range.

On the whole, the fauna of the archeological sites indicates that climate and biota have not changed appreciably from Carolinian hardwood conditions in southwestern Pennsylvania in the last five centuries.

ing Indian arrows as long as it was dry, a circumstance noted later by Acuña (1698).

Dampier furnishes us with further evidence of the manatee's occurrence on Central American coasts. Writing about 1675 he mentions the animal in several places, and says that the mouth of the Tobasco River, where it empties into the Bay of Campeche, "has manatees in great plenty, there being good feeding for them in many of its creeks." This bears out de Landa (*op. cit.*). Dampier goes on to say that there is a "sort of Fresh-water manatee, not altogether so big as the Sea-kind, but otherwise the same in shape and taste, and I think, rather fatter".

Esquemeling (1678) states that although manatees have no external ear, their hearing is quite acute. He also says that they reach a length of 20 to 24 feet.

The extensive account by Labat (1722) is a rather full description of manatees, their habits and distribution as they were then known.

One of the earliest records from continental North America is that of Bartram (1791) who says that in his day Manatee Springs, in Florida, was frequented by the beasts in the winter season, and that the Seminole Indians killed them for food, calling them by a name meaning big beaver, and prizing their bones as a good grade of ivory.

Gumilla (1791), writing at the same time as Bartram, reported manatees from the Orinoco; Clavijero (1780) says that they were found off the Mexican coast, and, according to Humboldt (1852–3), the Piaroas, of the Meta (an Orinocan tributary), said that their people invariably died when they ate manatee meat. Wallace (1853) saw manatees in the Rio Negros and gives an excellent description of them, while Bates (1864) found "vacca Marina" at Ega on the Amazon, and considered the meat greatly inferior to beef.

Herrera's (*op. cit.*) statement that manatees were found on the coasts of Guatemala is borne out by Brigham (1887), who says that "the manatee, or lamentin, once found in the Golfo Dulce, is now seldom, if ever, seen, although still found in British Honduras, where the hide is used for whips, canes, etc." A more modern writer who testifies to the comparative plenty of sea-cows in Honduras is Gann (1925, 1926, 1927, 1929) who mentions them repeatedly as occurring at Belize and other places on the Honduran coast, and who says that one particular location, "Mojo Cay was evidently used by the ancient Maya as a fishing station, to which they resorted to capture manatee, or sea cows, and to fish, as innumerable flint spear heads have been found here, with thousands of circular pottery rings, probably used as net sinkers. Many tons of manatee bones have been washed out from the northern end of the cay, where they had been dumped by the ancient inhabitants, who doubtless struck these great, unwieldy mammals with flint-headed lances."

Other recent and casual references are Beddard (1900); Elliot (1901); Fewkes (1907) "used as food by Porto Rican aborigines"; Oswald (1911); Scharff (1911); Roth (1915), folklore of the Guiana Indians; Nelson (1916); Lucas (1916); Beebe (1927), in the Essequibo, at Georgetown, British Guiana; Conzemius (1932), as food of the Miskito and Sumu Indians of Honduras; Hatt (1934),

from the Congo; Barrett(1935) from Nicaragua; Gunter (1941), Texas and the Gulf Coast; and Barbour (1944), Florida.

METHODS OF CAPTURE

Manatees can be caught with harpoons, fish arrows, weirs, or nets. Early accounts from Florida tell us that the Timucuan Indians hunted manatees from canoes, lassoing them, and driving a sharpened stick or crude harpoon into their noses to stop their breathing, and thereby keep them from submerging. The animals were then worried to death (Elliot, 1942), the Indian weapons not being of such caliber as to allow of their immediate dispatch.

According to Oviedo (*op. cit.*) the Spaniards hunted them with crossbows, tying a cord to the end of the bolt which was discharged at the animal. A float was tied to the end of the cord and thrown overboard to mark the position of the manatee, and to facilitate its recovery when it became exhausted from exertion and the loss of blood.

De Landa (*op. cit.*) says that the Mayans harpooned the beasts (*vide* Gann), a practice followed by the Amazonian Indians whose harpoons were made of shell. Orinocan Indians used a double-barbed harpoon tied to their canoes by a rope of manatee hide. Two people were in a canoe, the paddler and harpooner, and they pursued the beast in the utmost silence (a point insisted on by most writers). Once the manatee was killed it was loaded into the canoe in a most ingenious manner. Both Indians leaped into the water, holding on to the sides of their vessel, and tilted it so that it filled with water. The canoe was then easily pushed under the manatee, and by means of bailers, which until now they had worn on their heads like a cap, the canoe was emptied, and rose with its load until it could once more be paddled (Gumilla, *op. cit.*). A similar method is used by the Indians of the Rio Negros.

The Corentyn River Arawak use a 3-pronged fish arrow with which to shoot manatees, generally hunting by moonlight (St. Clair, 1834). Roth (1924) quotes a statement that the manatee can occasionally be taken by hanging a portion of the flower of the moku-moku so that it almost touches the water where the beast is supposed to be. As the creature approaches the bait it is shot with arrows. Wallace (*op. cit.*) speaks of manatees being caught in a strong net and killed by driving wooden plugs into their nostrils, a method followed in Honduras (Gann, 1926) and in Guiana, where the animals are trapped by the use of weirs or fences. Taking note of channels leading from the large lakes into the rivers, the Indians have built these across them with thick stakes, crossbeams, and supports, a whole village lending assistance with the work. As the turtle, lauláo, (50 to 75 lbs) and manatee (500 to 750 lbs) come down from the lakes, whither with the rising waters they went in search of fresh food, they are blocked by these fences. Notwithstanding the great strength of these structures, it is lucky if they have not to be repaired two or three times a year, so great is the impact of the shoals of fish, turtle and manatee running against them (Gumilla, *op. cit.*).

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SOME OBSERVATIONS ON THE BIG BROWN BAT IN SAN DIEGO COUNTY, CALIFORNIA

By Philip H. Krutzsch

The big brown bat, *Eptesicus fuscus*, is one of our most familiar chiropterans yet there is scant material available concerning its habits. It is, therefore, deemed worthy to add the following notes on observations made of these bats.

Eptesicus apparently are migratory in the San Diego Region as they have been recorded only during seven months of the year. The earliest record is that of a female taken from a barn on the grounds of The Old People's Home, Santee, on March 8, 1940. The latest recording for the year is that of a male captured in a deserted mine tunnel at Boulder Creek on September 21, 1943.

These bats take wing early in the evening, before dark has completely set in. A colony of 25 members was seen to leave its daylight retreat—in a rock crevice, 1½ miles north of Barrett Junction—at 6:35 p.m., long before complete darkness. A female of this species was shot while flying over a grove of eucalyptus trees at 6:55 p.m. Still another was taken by the same method just at dark, at 7:30 p.m. They evidently continue feeding later into the evening. A colony at the Old People's Home was visited at 8:15 p.m., and the bats were seen flying in and out of the roosting place. They would capture insects and then come in and hang up to eat. Many legs, wings and hard parts of their prey were found under these roosting places.

Big brown bats have been taken from all life zones in San Diego County. They have been discovered roosting in a variety of habitats. I have divided these into two categories—natural and man made.

NATURAL ROOSTS

Rock Crevice.—A colony was discovered inhabiting a rock crevice in a cliff, 1½ miles north of Barrett Junction, August 6, 1941. Another group was also found in a second crack in this cliff.

MAN MADE ROOSTS

Mine Tunnel.—A male *Eptesicus* was captured in a deserted mine tunnel at Boulder Creek, September 2, 1943.

Buildings.—A colony was discovered occupying a barn on the grounds of The Old People's Home on March 2, 1940. A second colony was located living in a barn at Harbison Canyon, May 30, 1941, and a third in a barn located in the center of a citrus grove, one mile east of San Luis Rey Mission, June 16, 1943.

Eptesicus were found to occupy the open garage of the San Diego County Road Station no. 2, 2 miles east of Spring Valley, April 27, 1943. Another colony was discovered inhabiting the loft of the San Diego County Road Station no. 3, 1½ miles north of Poway, June 16, 1943.

A large colony was found roosting between the walls of the Betsworth's Ranch House, 2 miles northwest of Valley Center, June 20, 1943. One male was taken from behind the shutters of a deserted cabin, located near The Crestline

Store, Palomar Mt., on June 20, 1943. Bats of this species were found hiding behind the shutters in an old deserted CCC Barracks, at Lower Doan Valley, Palomar Mt., May 7, 1940.

A colony occupied the attic and eaves of the San Marcos Church, San Marcos, on April 25, 1941.

Bridges.—A colony of *Eptesicus* was living between the "I" beams of a bridge at the juncture of Highways 79 and 80, 2 miles east of Bohemia, on May 1, 1943. Another group was situated in a similar location on a bridge at Green Valley Falls, on the same date.

Behind Sign Boards.—Big brown bats were found roosting behind a tin Coca Cola sign on the store at Hulbard's Grove, August 3, 1943, and a small colony was ensconced behind a sign board on the front of the Descanso Store, Descanso, May 1, 1943.

ASSOCIATION

In San Diego County I have frequently found this bat in association with bats of other species. In these cases of multiple colonization in a roosting place, each species was segregated from the other. Occasionally single individuals would be found together, but for the most part, they maintained their colonial solidarity. Apparently these colonies live peacefully in their separated areas within the roosting place. Future study might prove differently, but to date, I have seen no animosity exhibited by them.

Eptesicus, *Tadarida*, and *Antrozous* have been found living successfully in the same building, a barn on the grounds of The Old People's Home, in the attic of the San Marco Church, and in various cracks between the "I" beams of the bridge at the juncture of Highways 79 and 80.

Tadarida and *Eptesicus* were found together between two side bracings in the Highway Road Station no. 2, and in the loft of the Highway Road Station no. 3.

Eptesicus and *Corynorhinus* were found inhabiting the same section of a deserted mine tunnel at Boulder Creek on September 2, 1943.

REPRODUCTION

Parturition apparently takes place during the latter part of May and early June in the San Diego Area. I have notes on observations made on four colonies of *Eptesicus* which indicate that one young per female is usual; in one instance two offspring were noted.

In the colony at the Old People's Home on June 14, all adult females were carrying one about half-grown young. Three were frightened from their roosting place and flew to another building. Their young clung tightly to them and, other than slowing their flight, apparently did not hinder the mother's movements. The bats at Highway Road Station no. 3, on June 16, were carrying one young each. These were smaller than those observed at Santee, June 14. Those living in the barn, 1 mile east of San Luis Rey Mission, were carrying one young each on June 16. These young bats were small and appeared to be the same age as those at Highway Road Station no. 3. Two females with attached

young, when released from 5 feet in the air, were able to fly. A third after repeated attempts at a similar height, could not take wing. At the Betsworth's Ranch House on June 20, many females were seen to carry one young. One bat when captured had two offspring clinging tightly to her teats. Two bats carrying one young each easily flew from the wall of the house.

SUMMARY

Eptesicus in San Diego County either are migratory or hibernate in some yet undiscovered place, as they have been taken only in seven months of the year. These bats take wing early in the evening before darkness has set in, and continue feeding after complete darkness. They have been taken in all life zones of San Diego County and live in natural and man-made hiding places, often in association with other bats. Parturition occurs in late May or early June. *Eptesicus* usually have one young, rarely two.

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FIRST RECORDS OF TWO BEAKED WHALES, *MESOPLODON BOWDOINI* AND *ZIPHIUS CAVIROSTRIS*, FROM THE PACIFIC COAST OF THE UNITED STATES[1]

By Carl L. Hubbs

In 1945 two genera of beaked whales, which, apparently, have not hitherto been reported from the Pacific Coast of the United States, were collected in San Diego County, southern California. One of the species (Pl. 4) is identified as *Mesoplodon bowdoini* Andrews, which appears to have been known only from two specimens collected in New Zealand. The record, therefore, seems to be the first for the species from the Northern Hemisphere and the first for the New World.

The other species, *Ziphius cavirostris* Cuvier (Pls. 1–3), has been reported from various localities throughout the world but not, so far as we can learn, from the Pacific Coast of the United States. There are 6 or 7 records of *Ziphius cavirostris* from the Atlantic Coast of North America (Ulmer, 1941, pp. 119–120) and several from Bering Island in Bering Sea and one from Kiska Harbor in the Aleutian Islands (True, 1910, p. 31). It has been recorded from British Columbia by Cowan and Hatter (1940, p. 9), on the basis of an incomplete wave-worn skull. Another whale, from Estavan Point, Vancouver Island, was recently figured and discussed by Cowan (1945) as having the head form much like that of *Hyperoodon ampullatus*. It seems to be distinct from *Ziphius cavirostris*, even though the skeletal fragments were reported to match the corresponding parts of that species. I have found no reports of *Ziphius* from any point nearer to California than British Columbia. Southward from California in the Pacific Ocean I note no records of this genus short of New Zealand, whence there are several occurrences (Oliver, 1922, pp. 576–577). Fraser (1938, p. 276) stated that this species has been reported from various parts of Europe, and

[1] Contributions from the Scripps Institution of Oceanography, New Series no. 292.

from Massachusetts, Buenos Aires, Cape of Good Hope, India, Queensland, Tasmania and New Zealand. Localities represented by the relatively numerous records of recent years include New Ireland (Hale, 1931), Java (Dammerman, 1926), and Japan (Ogawa, 1937 a–b). The species, or species group, appears to warrant the attributive, cosmopolitan. Whether more than the one species of *Ziphius* exists is a debated question.

The fact that the two wide extensions of range were made in a single year probably merely reflects the lack of attention that has been paid to the beaked whales. These cetaceans are probably much less rare than is generally thought. Ordinarily, they are not to be seen at whaling stations for they do not have sufficient commercial value to be taken commonly in the whale fishery. Occasional specimens, however, become stranded on sandy beaches, where they may be examined and skeletonized by sea-coast zoologists who are alert enough to hear of the occurrences and are willing to tolerate a little inconvenience and stench. By such action much new information can be obtained regarding the distribution and abundance of the smaller whales. In this connection we note that *Ziphius cavirostris* was formerly believed to be rare in the vicinity of the British Isles, but that no fewer than 20 well-authenticated records of this species were accumulated during the quarter century following 1913 when the systematic recording of stranded cetaceans in Great Britain was begun (Fraser, 1938, p. 276).

The lack of previous records of either *Mesoplodon bowdoini* or *Ziphius cavirostris* from the Pacific Coast of the United States is attested by examining True's 1910 monograph on the beaked whales, the lists of the mammals of North America (Miller, 1924) and of California (Grinnell, 1933), the Zoological Record, and other literature examined. In Scheffer's (1942) list of West Coast marine mammals *Mesoplodon stejnegeri* and *Ziphius cavirostris* are included, but presumably on the basis of the far-northern records given by True (1910). Neither Dr. Remington Kellogg, of the United States National Museum, nor Dr. Seth B. Benson, of the Museum of Vertebrate Zoology at the University of California, knows of records from the Pacific Coast of the United States for either of these whales.

Assistance in the collection and preparation of the two specimens was kindly furnished by Laura C. Hubbs, Elizabeth M. Kampa, Robert R. Harry, Jr., and other workers at Scripps Institution of Oceanography. Laurence M. Huey of the San Diego Museum of Natural History helped in skeletonizing the *Mesoplodon*. I am particularly indebted to Dr. Remington Kellogg for the identification of the *Mesoplodon* specimen, for the measurements of both skulls and of both mandibles, and for literature references and general advice, without which I would not have ventured to prepare this note. In fact Dr. Kellogg should have appeared as the author or at least the co-author, even though pressure of other work, related to the war, limited the time that he could spend on the study of the two specimens discussed below.

ZIPHIUS CAVIROSTRIS CUVIER

An immature female of the "Cuvier whale" or "goose-beaked whale" was stranded on September 24, 1945, on the sand beach at Del Mar, San Diego

County, California (at about 32° 57′ 30″ N. Lat., 117° 16′ 00″ W. Long.). It was examined, photographed and measured on the following day. The skull, mandibles, 7 cervical and 3 dorsal vertebrae, and the left pectoral flipper were rough-cleaned and later dried and salted. The tongue, the hyoid apparatus, and the pelvic girdle with cloaca and clitoris were preserved in alcohol. Both eyes were injected with and preserved in 10 per cent formalin solution. The material is all deposited in the U. S. National Museum (Cat. no. 278668).

This specimen (Pls. 1–3) is identified as *Ziphius* because of its agreement in external features, dentition and skeleton with *Ziphius cavirostris* as described by various authors, particularly by True (1910, pp. 30–60, Pls. 14–25, 34–38, 41). The specific identification is made in agreement with True's opinion, shared with other cetologists, including Harmer (1915) and Allen (1939, pp. 262–263), that the several nominal species of *Ziphius* were probably based on differences that are due to age, to sex, and to individual variation. Some authorities, for example Iredale and Troughton (1934, p. 61), still recognize species of *Ziphius* other than *cavirostris*. The data from the immature female at hand do not bear significantly on the problem. The cranium, with bones that had not yet begun to fuse, had not acquired the cranial peculiarities of an old adult.

The color of the well-preserved external surface was deep leaden gray above, approaching blackish, and only moderately lighter, definitely not whitish, below. The entire beak and the fins were dark.

Consistent with its sex and immaturity, the specimen (Pl. 1, fig. 3) did not exhibit the white scars and streaks that were so conspicuous in the other beaked whale that was collected, as also in many other adult males of this family. There were, however, some oval healed scars about 1 × 1½ inches in size, suggesting tooth marks, on the posterior part of the body. The white areas on the flukes (Pl. 2, fig. 1) represent damage in the surf.

The beak (Pl. 1, fig. 2) was moderately prominent and the forehead rose at a very obtuse angle—more sharply than in the Rhode Island specimen figured by True (1910, Pl. 41, fig. 4) but very much less steeply than in the photograph of the beaked whale just reported from British Columbia by Cowan (1945, pp. 93–94, Pl. 1) and thought to be possibly referable to *Ziphius*. The lower jaw projected slightly. The form of the flukes is shown in Plate 1, figure 1. The caudal peduncle was very high and sharp-edged above and below. The pectoral flipper was weaker and proportionately shorter than in the specimen of *Mesoplodon bowdoini* reported below. The dorsal fin was inserted well behind the middle of the body, farther back relatively than in *Mesoplodon*. Its posterior edge was concave, with a contour that merged into that of the body.

The skin of the dorsal surface from near the blow hole to the dorsal fin was very finely fluted longitudinally, but this condition may well have resulted from rolling back and forth at the edge of the surf. The epidermis was definitely thicker and more rubbery than in the specimen of *Mesoplodon bowdoini*. The shallow throat grooves converged forward but did not meet (perhaps because the thoat was stretched as a result of bloating). On the back behind the head the blubber was 2¾ inches thick.

A feature that attracted attention was the broad olive-gray tongue (Pl. 1, fig. 2), which bore very conspicuous fimbriae along its lateral margins anteriorly and shorter fimbriae around its front edge. The following description of the tongue was provided by Dr. Remington Kellogg :

> On the oral surface . . . the filiform papillae on lateral margins occupy a space about 20 mm. in breadth and extend backward on sides for a distance of 120 mm. from the tip. These papillae seemingly are arranged roughly in six rows on each side. Some of the longer ones are bifurcated. [Some groups of] three to four are joined together for about three-fourths of their length . . . The tongue . . . has a V-shaped papillate area on the upper surface, the apex of which is located about 125 mm. behind the tip of the tongue. The papillae in this area are shorter than those on the lateral margin of the tongue.

Turner (1886) and Sonntag (1922) described the tongue of *Mesoplodon bidens* but made no mention of this organ in *Ziphius*.

The mandibular tusks, as would be expected, were hidden in the gum, but were typical in form and position. In both upper and lower gums numerous small teeth were imbedded. On the right mandible there appear to have been 33 or 34 such teeth, some as long as 6 mm. The vestigial teeth of this species were described by Fraser (1936).

As measured along the median lateral line of the somewhat bloated body, from tip of lower jaw to middle of caudal flukes, this specimen of *Ziphius* was 15 feet, 1 inch long. From measurements on a photograph it is estimated that the straight-line or standard total length was about 14 feet, 4 inches. Various other external measurements are expressed in Table 1 as thousandths of the total length. Measurements in millimeters and proportional measurements of the skull are given in Table 2 and of the mandible in Table 3. The skull (Pls. 2–3) closely resembles that of the young adult female figured by Kernan (1918).

MESOPLODON BOWDOINI ANDREWS

Late in the evening of July 25, 1945, a small whale, in obvious distress, was observed in the surf of the beach just south of Scripps Institution of Oceanography, near La Jolla, San Diego County, California (at 32° 51′ 41″ N. Lat., 117° 15′ 19″ W. Long.). According to several observers, about seven men went into the surf late that night, attached a rope to the creature's tail, and pulled it ashore amid wild thrashing. Some spoke of seeing two whales fighting in the surf, but the statements may have stemmed from supposition. On July 26–27 the entire skeleton was saved (the hyoids and pelvis in alcohol). The dorsal fin and one tip of the caudal flukes were kept in alcohol and one eye was injected and preserved in formalin. All of this material is deposited in the United States National Museum (Cat. no. 278031).

At first it was thought that this specimen might represent *Mesoplodon stejnegeri* True (1885, pp. 584–585; 1910, pp. 24–30, Pls. 3, 6, 9–12, 34–37), because of similarities in the skeleton and especially in dentition. Closer inspection and comparison, however, indicated to Dr. Remington Kellogg that the skull differs markedly from the three known examples of *M. stejnegeri* from Bering

Island in Bering Sea and from Yaquina, Oregon (all in the United States National Museum). In the ossified rostrum, the forward curvature of the vertex and the configuration of the base of the rostrum and other characters, the skull

TABLE 1.—*External measurements of beaked whales, expressed as thousandths of the estimated total length*[1]

	ZIPHIUS CAVIROSTRIS immature female (U.S.N.M. 278668)	MESOPLODON BOWDOINI adult male (U.S.N.M. 278031)
Length over curved side of body from tip of lower jaw to middle of margin of flukes	15 feet, 1 inch	17 feet, 4 inches
Estimated total length in straight line[2]	437 cm.	505 cm.
Upper jaw tip to dorsal fin base	663	621
Notch at front of dorsal fin to notch at base of flukes (straight line)	337	362
Lower jaw tip to front of anus	648	646
Center of anus to front of dorsal base	154	224
Length of anal slit	About 58	41
Rear end of anus to middle of margin of flukes	346	383
Greatest half circumference of body	273[3]	242[4]
Dorsal fin height from front of base to apex	73	75
Dorsal fin base to junction with body contour	76	88
Pectoral flipper length from front angle to tip	99	108
Pectoral flipper base	52	49
Caudal peduncle, least circumference	125	136
Flukes from basal indentation to middle of margin	87	91
Caudal keel end to margin of flukes	41	43
Flukes, tip to tip	256	....
Upper jaw tip to middle of eye	126	126
Upper jaw tip to end of mouth crease	64[5]	97[5]
Projection of lower jaw	3	5
Lower jaw tip to tooth tip	....	45
Tooth tip to middle of eye	....	88
Length of orbital crease	10	5
Length of throat groove	26 or 36[6]	40
Width of blow-hole	30	19

[1] The measurements were taken with a steel tape, except as noted, over the curve of the body or head.

[2] Computed by proportion of the length over the curved sides to axial length, from measurements of photographs.

[3] Increased by moderate bloating of body.

[4] At a point 58.5 inches behind middle of eye.

[5] Since the end of the crease is rather indefinite the two specimens may not have been as different as these figures indicate.

[6] Lengths of deep portion and maximum measurement, respectively.

agrees with those of the two known examples, both from New Zealand, of *Mesoplodon bowdoini* Andrews (Andrews, 1908; Oliver, 1922, pp. 569–572, Pls. 3–4). In the curvature of the mandible also our specimen corresponds with *M.*

bowdoini and differs from *M. stejnegeri*. In this respect there is a notably strong contrast with *M. densirostris* (Blainville), with which *M. bowdoini* agrees in the ossified rostrum. Dr. Remington Kellogg writes that the mandible of the young whale from Japan that was recorded by Ogawa (1938, pp. 207–214, fig. 26, Pls. 12–14) as *M. densirostris* is quite unlike known mandibles of that species. He thinks that the specimen was either *M. stejnegeri* or *M. bowdoini*. The California example differs trenchantly in the size and position of the teeth and in other characters from all other species of *Mesoplodon* as treated by Flower

TABLE 2.—*Measurements of skulls of ziphiid whales, expressed in millimeters and (in parentheses) as thousandths of the greatest skull length*

	ZIPHIUS CAVIROSTRIS	MESOPLODON BOWDOINI		
	California[1]	New Zealand[2]	New Zealand[3]	California[4]
Greatest length, tip of premaxillaries to occipital condyles	716 mm.	715 mm.	720 mm.	820 mm.
Height, vertex to inferior border of pterygoids.....	331 (462)	311 (435)	302 (419)	342 (417)
Width at center of orbits.....	361 (504)	325 (455)	318 (442)	418 (510)
Zygomatic width.....	379 (529)	335 (469)	331 (460)[6]	405 (494)
Width across occipital condyles ..	137 (191)	113 (158)[5]	112 (155)[6]	131 (160)
Length of rostrum, from level of antorbital notches to tip	384 (536)	428 (599)	435 (604)	500 (610)
Width of rostrum at base, between antorbital notches.....	215 (300)	193 (270)	—	245 (299)
Width of rostrum at middle.....	90 (126)	52 (73)	45 (63)[6]	62 (76)
Depth of rostrum at middle.....	44 (61)	73 (102)	64 (89)[6]	102 (124)

[1] This skull is figured on Plates 2 and 3. The measurements were made by Dr. Remington Kellogg.

[2] Copied (and computed) from measurements of type given by Andrews (1908, pp. 203–204).

[3] Copied (and computed) from measurements given by Oliver (1922, pp. 569–570).

[4] The measurements for this specimen were made by Dr. Remington Kellogg. They may be very slightly too high, as traces of dried skin remained on the skull.

[5] Computed from measurements of Andrews' figures (1908, Pl. 13).

[6] Computed from measurements of Oliver's figures (1922, Pl. 3).

(1878), Forbes (1893), Beddard (1900, pp. 213–221, fig. 28), True (1910, pp. 3–30, Pls. 1–13, 34–37, 40–41), Harmer (1924), Raven (1937), and Fraser (1938, pp. 276–282, figs. 71, 73). It is also quite unlike *M. pacificus* Longman (1926, pp. 269–273, Pl. 43), from Queensland, which Raven (1937, pp. 22–25) regarded as a subspecies of *M. mirus*.

Except for the whitish beak (Pl. 4, fig. 1) this whale was almost jet-black over the entire surface, venter as well as dorsum. In different lights the sheen varied from bluish to brownish.

As is clearly shown in the photograph (Pl. 4, fig. 2) the sides were marked at

TABLE 3.—*Measurements of mandibles and mandibular teeth of ziphiid whales, expressed in millimeters and (in parentheses) as thousandths of the length of the mandible*

	ZIPHIUS CAVIROSTRIS	MESOPLODON BOWDOINI		
	California[1]	New Zealand[2]	New Zealand[3]	California[1]
Length of mandible	592 mm. / —	628 mm.	63 cm.	696 mm. / 670 mm.
Length of symphysis	118 (199)	146 (232)	150 (238)	177 (259)
Greatest height at coronoid process	93 (157) / 100 (169)	115 (183)	103 (164)[5]	118 (170) / 118 (176)
Depth at posterior margin of tooth	—	82 (131)[4]	72 (115)[5,6]	81 (116) / 84 (125)
From anterior end to front of tooth at base	—	153 (243)[4]	135 (214)	174 (250)[5]
Depth at angles	118 (199) / 122 (206)	127 (202)	125 (198)	130 (187) / 126 (188)
From condyles to posterior margin of tooth	570 (963) / 569 (961)	395 (629)	393 (623)	441 (634) / 438 (654)
Least depth behind tooth	— / 23 (39)	65 (103)	70 (111)	69 (99) / 71 (106)
From ventral face to apex of tooth crown	—	135 (216)[4]	140 (222)[5]	157 (226) / 153 (228)
Tooth measurements:				
Anteroposterior diameter at alveolar margin	—	75 (119)	110 (175)[7]	84 (121) / 83 (124)
Transverse diameter at alveolar margin	—	—	—	12.5 (18) / 13 (19)
Height of enamel crown	—	28 (45)[4]	27 (43)[5]	42.7 (61)[5]
Anteroposterior diameter of enamel crown	—	33 (53)[4]	31 (49)[5]	63 (91)[5]
Maximum transverse diameter of enamel crown	—	—	—	15.5 (22)[5]

[1] The measurements in this column were made by Dr. Remington Kellogg. Where two figures are given, the upper one is for the left side, the lower for the right. For the California specimen of *M. bowdoini* the length used in computing the proportions was the average of the measurements of the two mandibles.

[2] Copied (and computed) from measurements of type given by Andrews (1908, p. 204).

[3] Copied (and computed) from measurements given by Oliver (1922, p. 570).

[4] Computed from measurements of Andrews' figure (1908, fig. 2) of right ramus of mandible.

[5] Computed from measurements of Oliver's figure (1922, Pl. 4, fig. 2) of left ramus of mandible.

[6] Low value appears from the figure to be due to breaking of alveolar wall.

[7] High value appears from the figure to be due to breaking of alveolar wall.

[8] Left ramus.

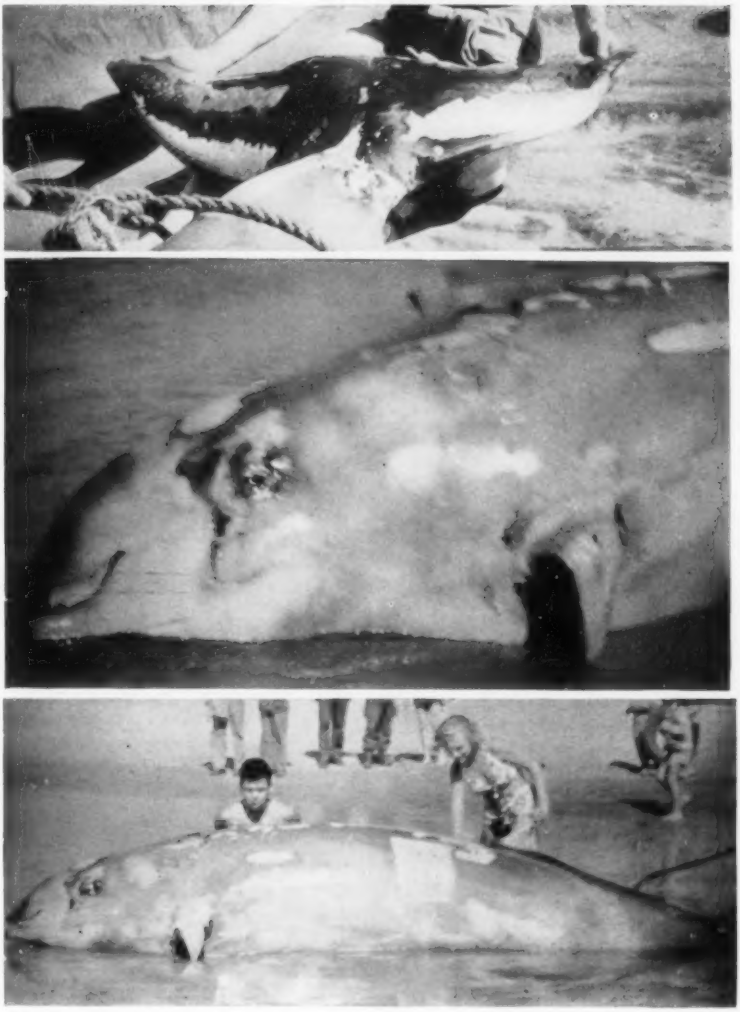

PLATE 1

Beaked whale, *Ziphius cavirostris* Cuvier, stranded at Del Mar, California. From kodachromes by Laura C. Hubbs.

FIG. 1. (UPPER) Caudal flukes. The whitish areas represent damage caused by rolling in the surf.

FIG. 2. (CENTER) Anterior parts in slightly oblique view.

FIG. 3. (LOWER) Entire specimen in side view.

random by very prominent white streaks, which were obviously the healed scars of long gashes inflicted in combat by the huge tusks of another male. Some of the seemingly fresher streaks lay in slightly recessed grooves with

PLATE 2

Skull of *Ziphius cavirostris*, from immature female specimen stranded at Del Mar, California. Skull cleaned, but not degreased. Photographs by Paul Williams.

FIG. 1. (UPPER) Dorsal view.

FIG. 2. (LOWER) Lateral view.

puckered edges. One long gash, doubtless an unhealed wound, penetrated deep into the blubber. In addition to the streaks, elliptical shining-white spots about $1\frac{1}{2} \times 5$ inches in size were present. There were about 12 such spots on the right side near the ventral surface. Only a few occurred near the middle

of the sides. The fact that most of the spots were ventrolateral perhaps indicates that the fighting male attacks from below and from the side. There can

PLATE 3

Skull of *Ziphius cavirostris*, from immature female specimen stranded at Del Mar, California (cont.). Photographs by Paul Williams.

FIG. 1. (UPPER) Posterior view.

FIG. 2. (LOWER) Ventral view.

be little doubt that the elliptical marks were the scars of tooth incisions. Several were concave and a few showed scar tissue. Near the ventrolateral spots two

elliptical gashes, obviously recent tusk imprints, extended half-way through the blubber. A transition could be traced between these holes and the white areas

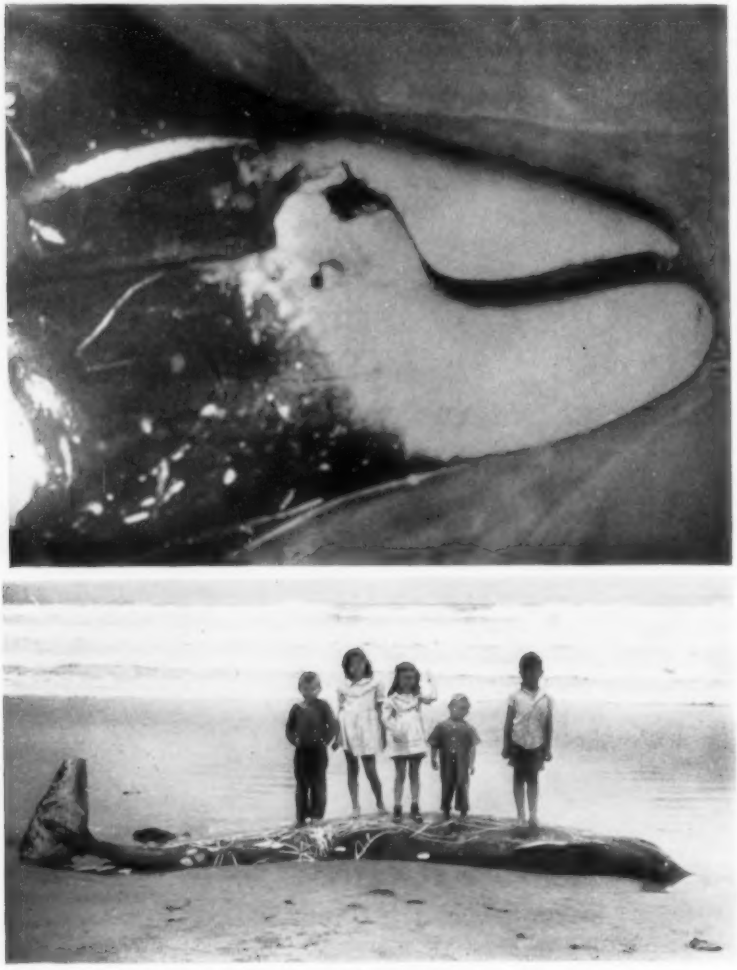

PLATE 4

Beaked whale, *Mesoplodon bowdoini*, stranded near La Jolla, California.

FIG. 1. (UPPER) Side view of head, showing the beak and the tusk. From kodachrome by Robert R. Harry, Jr.

FIG. 2. (LOWER) Entire specimen, showing battle scars. Photograph by Paul Williams.

that were flush with the general surface. The median part of the fluke was largely white by reason of the thickly overlapping white streaks.

The head (Pl. 4, fig. 1) was strongly gibbous behind the rather thick beak but the dorsal contour of the head was not sharply angulated. The strong lower jaw definitely projected. The throat grooves converged but failed to meet anteriorly. The keels on the upper and the lower edge of the caudal peduncle were rather sharp and terminated on the fluke, which had a crenate posterior border (Pl. 4, fig. 2). The flipper was large. The dorsal fin was inserted much nearer the end of the flukes than the end of the muzzle. Its concave posterior edge graded into the dorsal contour of the body.

The epidermis was paper-thin. Just behind the head the blubber was about 2½ inches thick all around the body. About one-half square yard of blubber yielded 3 gallons of clear yellow oil. The meat was very red and turned blackish on holding, but was of good flavor and tender when roasted or fried. About 100 pounds were eaten by local residents. This addition to the war-rationed meat supply was much enjoyed.

The penis was retracted but apparently fully developed. It approached three feet in length and the erectile tissue was about two inches in diameter. The testes were only about 3 × 4 inches in size. Just behind the hyoid the outside diameter of the trachea was 3⅛ inches. The alimentary tract was empty.

As measured over the curved side, the length was 17 feet, 4 inches. The straight-line total length is estimated to have been 16 feet, 7 inches. Proportional measurements expressed as thousandths of the total length are listed in Table 1. Skull measurements and proportions appear in Table 2 and mandible and tooth measurements and proportions in Table 3. As indicated in the second table, the skull of the California specimen is larger than that of either of the New Zealand specimens.

On July 31, six days after the specimen described above was stranded, workmen at Scripps Institution of Oceanography saw a similar whale, likewise marked with white streaks, passing the end of the 1,000-foot Scripps Pier. Jack Prodanovich, an expert goggle fisherman, reports that he first saw the second whale as it swam south around the reef at the north end of the Institution. It veered offshore to round the pier and presumably continued south, for shortly afterward he saw what appeared to be the same animal leaving the little cove at Casa Mañana on the west side of La Jolla. Still later he saw it between La Jolla and Bird Rock. It kept swimming leisurely southward, apparently always close to the rocky shore. Its length was estimated to be about 20 feet.

SUMMARY

On the basis of two specimens recently stranded in San Diego County, California, two genera of beaked whales of the family Ziphiidae are reported for what seems to be the first time from the Pacific Coast of the United States. The genera are *Ziphius* and *Mesoplodon*. The species of *Ziphius* is probably *Z. cavirostris*. The species of *Mesoplodon* is identified by Dr. Remington Kellogg as *M. bowdoini*, which appears to have been known only from two specimens taken in New Zealand.

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ADDENDUM

Early in January, 1946, a third whale came ashore near La Jolla, California. It was a sperm whale, *Physeter catodon* Linnaeus, about 40 feet long. It was stranded immediately north of the Scripps Institution of Oceanography.

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NOTES ON THE COMPARATIVE OSTEOLOGY OF THE BOBCAT AND THE HOUSE CAT

BY KEITH R. KELSON

Since the genus *Lynx* is separated from all other modern cats, primarily on the loss of certain dental elements, it seemed that it would present some interesting features from a phylogenetic as well as from an adaptive standpoint. Also, inasmuch as the form *Lynx rufus baileyi* Merriam is one of the few felids inhabitating semiarid desert areas, it was felt that an anatomical comparison with another felid not of similar occurrence might afford some significant data. It is commonly believed that the family Felidae has attained a greater dental specialization for a carnivorous diet than any of the other Carnivora. If this is so, the question arises as to how *Lynx* compares with other felids in respect to this specialization. With these problems in mind, a study was initiated involving a description of the osteology of the bobcat, *Lynx r. baileyi*, a consideration of the osteological adaptations of *Lynx*, and an inquiry into the osteological similarities and dissimilarities of *Lynx* and a member of the genus *Felis*.

As a basis of comparison, the common house cat was selected as representative of the genus *Felis*. It was chosen for several reasons: it is readily available, its anatomy has been the subject of many exhaustive investigations, and it is closely related to *Lynx* and yet differs in its habits and environment.

Specimens for this study were taken from various localities. Care was taken that specimens of *Lynx* were collected from areas well distributed throughout the animal's range, and it is felt that the specimens were fairly representative of the

species. House cats were procured locally so that ages would be known. The skeletal material was prepared by the standard maceration technique; measurements were made by dial vernier calipers, calibrated to tenths of a millimeter. Certain specimens were embalmed for muscular dissection so that osteological data might be interpreted.

I wish to thank R. V. Chamberlain and S. D. Durrant of the University of Utah for their assistance and encouragement throughout the study; E. Raymond Hall, University of Kansas, assisted in obtaining some of the skeletal material.

Although admittedly incomplete in certain respects, it seems advisable to make the findings of this investigation a matter of record at this time.

TABLE 1.—*Measurements in millimeters of skull and teeth of Lynx and Felis*

	LYNX						FELIS			
	♂	♂	♀	♂	♂	♂	♀	♀	♂	♂
Basilar Length	10.40	10.16	9.9	10.30	9.95	11.15	6.48	6.90	7.32	7.00
Palatal Length	4.66	4.78	4.47	4.78	4.74	4.90	2.70	2.98	3.26	3.12
Post nares to foramen magnum	5.80	5.45	5.46	5.58	5.32	6.08	3.78	3.87	4.09	3.93
Zygomatic breadth	9.09	9.01		8.65	8.32	8.80	5.44	5.87	5.61	6.00
Breadth at base of canine	3.27	3.25		3.18	3.00	3.20	1.97	1.96	2.23	2.24
Length of carnassial	1.52	1.48	1.40	1.35	1.44	1.40	.89	.93	1.07	1.05
Length of Pm.^{3}	.97	.95	.94	.92	.91	.90	.55	.56	.65	.64
Length of canine	1.90	1.83	1.70	1.85	1.64	1.76	.90	.97	1.19	1.24

SKULL

Skull As a Whole.—Grinnell and Dixon (1924) report that in *Lynx* the skull of the female was 78 per cent as large as that of the male. This statement was based on the air-dry weight of one specimen of each sex in which the age could only be approximated. The present investigation showed no such great difference. With reference to individual variations, the same authors stated that *Lynx* skulls are remarkably uniform; the variations are "rather less than with, say, the skulls of bears or coyotes." My observations corroborate their findings.

The skull of *Lynx* is, of course, much larger than that of *Felis*. Comparative measurements are given in Table 1. The skulls of the two animals are very much alike in their general appearance, being composed of the same bones which show about the same relationships. Numerous small differences are present, however, which seem to be environmental adaptations.

In *Lynx*, the lambdoidal ridge is ordinarily better developed. This is undoubtedly correlated with the necessity for strengthening the cervical musculature for killing larger prey. The sagittal crest is better developed in *Lynx* and is indicative of proportionally greater jaw strength. There is a slight comparative reduction in the cranial region of *Lynx*, accompanied by an increase in the facial region. Figure 1 shows that the facial region as measured from the zygomatic process of the frontal to the posterior edge of the middle incisor teeth is proportionately longer in *Lynx*. If this is not at first apparent from the illustration, it should be remembered that the lambdoidal ridge is larger in *Lynx* and therefore an outline drawing does not show the true face-cranium ratio.

The proportion of the length of the palate to the basilar length is about 47 per cent in *Lynx* and about 43 in *Felis*. While the difference is not great, it is quite uniform, and especially so in *Lynx*. The palatal length-breadth ratio is the same in both animals. The palate of *Lynx* is concave ventrally while that of *Felis* is almost flat.

The rostral length is slightly greater in *Lynx*. It is evident from Figure 1 that the facial plane of *Lynx* is more abrupt than in *Felis*. In *Lynx*, the nasal process of the premaxillary is narrower.

In *Lynx*, the portion of the zygomatic arch that forms a floor for the orbit is smaller in its craniocaudal measurement.

The most striking differences, however, occur in the dental region. The alveolar length of the upper cheek teeth of *Lynx* is proportionately shorter than in *Felis*. This is probably due to the loss of the 2nd premolar in the former. The tooth is retained in the genus *Felis*.

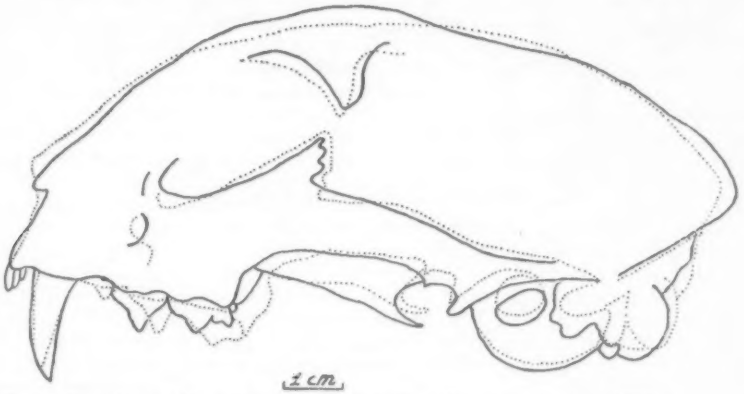

FIG. 1. Superimposed lateral aspects of the skulls of *Lynx* (————) and *Felis* (.....). (*Felis* enlarged to the size of *Lynx*.)

In *Lynx*, the caudolateral edges of the hard palate are smoothly semicircular; in *Felis*, they are deeply emarginate (fig. 2).

Occipital.—The occipital bones of *Lynx* and *Felis* are similar, both in their configuration and in their relationships with other bones. Both support the same structures. Where differences do occur, they are not constant. The principal difference is in the development of the lambdoidal ridge as already mentioned in connection with the skull as a whole. The external occipital protuberance is less marked in *Felis*.

Interparietal.—In *Felis*, the interparietal bears a less well-developed sagittal crest than in *Lynx*. This, too, may be correlated with the increase in size of musculature in this region. In *Lynx*, the external surface of this bone is more concave on either side of the crest than in *Felis*. This is due principally to the increase in the size of the crest.

Parietal.—The coronal suture is much more irregular in *Lynx*. Inasmuch as the sutures show considerable variation in different specimens, the significance of this is obscure. It does seem reasonable, however, that this articulation should be stronger in *Lynx* to support the proportionately more powerful muscles of the jaws. The parietal ridges are less marked in *Felis*, and while the parietal bones are much smaller they are almost as thick as those of *Lynx*. In *Felis*, the median vertical plate of the tentorium is comparatively small.

Frontal.—In *Felis*, the breadth of the frontal plate shows great variation. Since this feature is more constant in *Lynx*, an accurate comparison is difficult. In *Lynx*, the length-to-breadth ratio is intermediate to the extremes found in *Felis*. The parietal ridge is

much less pronounced in *Felis*, particularly at the base of the zygomatic process. The nasal spines of the frontal are commonly more slender and tapering in *Lynx*. The appearance of the lateral plate of the ethmoid in the orbit occurs more often in *Felis*, in which

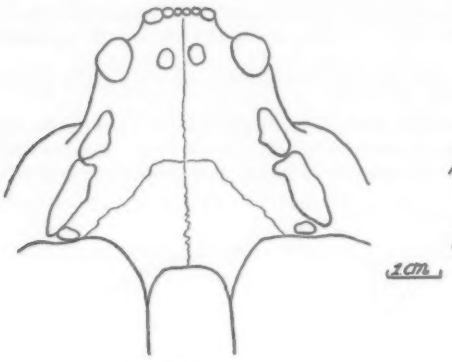

FIG. 2. FIG. 3

Hard palates of *Lynx* (Fig. 2) and *Felis* (Fig. 3)

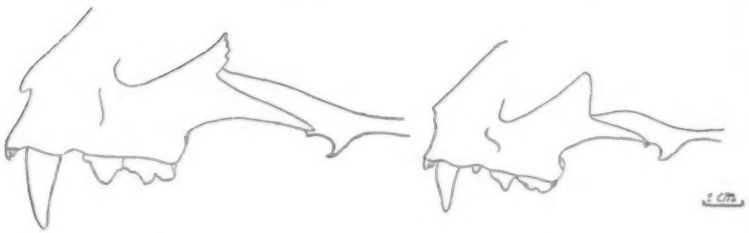

FIG. 4 FIG. 5

Malar and dental regions of *Lynx* (Fig. 4) and *Felis* (Fig. 5)

FIG. 6 FIG. 7

Lateral aspects of mandibles of *Lynx* (Fig. 6) and *Felis* (Fig. 7)

this interposed portion was double in several specimens. It was single in all specimens of *Lynx* in which it was present at all. The small orbital tubercle is almost completely lacking in *Felis*.

Nasal.—The nasal bones of *Felis* are more slender and tapering than those of *Lynx*. This condition indicates a broader and heavier muzzle in the latter, correlated with the

increased killing function of the jaws. In *Felis*, the caudal ends of the nasals are depressed in a pit between the nasal processes of the frontals and the caudal third of the nasal is curved toward the bottom of the pit. There is no such pit in *Lynx*. The nasals of *Felis* are concave ventrally throughout their length; only the cranial ends are concave in *Lynx*. In *Lynx*, the craniolateral projection is more styliform than in *Felis*. The concha nasalis superior is equally well developed in both animals.

Premaxillary.—In *Lynx*, the dorsal tip of the nasal process is usually more delicately formed than in *Felis*. Thus, in *Lynx* there is a larger percentage of individuals in which the frontal process of the maxillary does not touch the nasal. The grooves which extend forward from the incisive foramina are more pronounced in *Lynx*.

Maxillary.—In *Lynx*, the pit to receive the lower carnassial tooth is proportionately larger than in *Felis*. It is terminated at the caudal edge of the hard palate in *Lynx* and craniad to the edge in *Felis*. The caudal edge of the palate is smoothly confluent with the ventral border of the zygoma in *Lynx*, but is interrupted by a small tubercle in *Felis*. In *Felis*, the zygomatic process of the frontal lies at more of an angle with the sagittal plane of the skull than in *Lynx*. In *Lynx*, therefore, at least the cranial half of the zygoma more closely approaches the vertical plane than that of *Felis*.

Vomer.—The vomers of *Felis* and *Lynx* do not differ in any significant feature except size.

Ethmoid.—Since the facial region of *Lynx* is somewhat better developed than in *Felis*, it seems reasonable to expect that the turbinates would be proportionately more expanded in *Lynx*. The position, configuration, and variability of the bone, however, makes it impossible to obtain reliable measurements.

Palatine.—There is a slight difference in the caudolateral borders of the palatine in *Felis* and *Lynx*. In *Felis*, the palatine process of the maxillary is longer, and therefore, the caudolateral border of the horizontal plate of the palatine is recurved caudolaterally. Thus, from the occlusal aspect, the lateral portions of the palate are emarginate in *Felis*, but not in *Lynx* (fig. 2). The ventral lips of the posterior nares are nearly semicircular in *Felis*; almost straight in *Lynx*. The dorsal edge of the vertical plate is much more regular in *Lynx*. The exact extent of this plate varies in both animals due to its relationships with the os planum.

Lacrimal.—Comparison of lacrimal bones is difficult because they are so variable. The most apparent difference lies in the absence of the orbital tubercle in *Felis*.

Malar.—The general conformation of the malar is similar in the two animals. There is a slight difference in the arch as illustrated by Figure 1. In *Felis*, the malar is carried craniad over the lateral edge of the infraorbital foramen. This swelling is much less conspicuous in *Lynx* (figs. 1 and 2). The caudal tip of the malar tapers to a slenderer point in *Felis*.

Presphenoid.—In *Lynx*, the wing extends slightly farther dorsad into the orbit than in *Felis*. The external pterygoid fossa is more prominent in *Lynx*. In other respects the bone is similar in the two.

Sphenoid.—The alisphenoid of *Lynx* is wider in proportion to its length than that of *Felis*. This proportion is, however, somewhat variable. The internal pterygoid fossa is more clearly defined in *Lynx*. Since this fossa serves as the origin of the internal pterygoid muscle, an elevator of the lower jaw, this points to a proportionately increased elevation of the jaw in *Lynx*.

Temporal.—The temporal bones of *Felis* and *Lynx* differ in several respects. The tuberculum articulare is slightly more pronounced in *Lynx*. The postmandibular processes are not greatly different. The styliform processes are quite similar although in some specimens of *Lynx* they are especially well developed. However, since the degree of development seems to be independent of the animal's age, significance of size is doubtful. In general, the bullae of *Lynx* appear to be proportionately shorter than those of *Felis*. The petrous portions of the temporals are similar in both animals. Such differences as do occur are of no particular significance. In *Lynx*, the ventral tip of the mastoid process is usually more removed from the bulla, indicating an increase in the ventral neck musculature.

Mandible and Teeth.—In *Lynx*, the body of the mandible is almost straight from the

lateral aspect, while that of *Felis* is decidedly curved. Due chiefly to this difference, *Lynx* shows a more prominent "chin" than *Felis*. This immediately recalls to mind the straight mandibles of *Hoplophoneus*, *Smilodon*, and *Dinictis*. Because of the extreme enlargement of the upper canine of these early forms, the jaws were necessarily opened wide to permit the characteristic slashing stroke of the canines. In both the extreme angle of the lower jaw and the development of the canine, *Lynx* again recalls these primitive forms. The jaws of *Lynx* are able to open wider than those of *Felis*, primarily due to a medial deepening of the fossa between the condyle and the angular process. The area of the condylar surface is markedly increased ventrally in *Lynx*, as compared with *Felis*, and the canine teeth are longer and heavier. Particularly is this true of the upper canines.

The mandible of *Lynx* is deeper in proportion to mandibular length—20 per cent in *Lynx*, 15 in *Felis*. The ramus is proportionately wider in *Lynx*. As the mandible becomes heavier, it seems reasonable to assume that the elevating musculature would insert farther distally. This assumption is substantiated by the increased depth of the coronoid fossa in *Lynx*.

The incisor teeth show no great difference. Differences in the canines were mentioned above. In *Lynx*, Pm^2 is wanting; it is present in *Felis*. The other teeth do not differ significantly.

Ribs.—There is no significant difference in the ribs of the two species. Of minor importance is the fact that the first rib is straightest in *Felis*; in *Lynx*, the second is straightest.

Sternum.—There are no significant differences.

Atlas.—In *Lynx*, the caudal articular facets are better developed and extend farther mediad and ventrad. The principal differences are in the wings. In *Lynx*, the wing is proportionately larger, the caudal border appreciably longer, the anterior ridge well defined (almost wanting in *Felis*), and the caudal portion thickened abruptly (gradually in *Felis*). These differences point to a proportional increase in the cervical musculature in *Lynx*.

Axis.—The axes differ in several respects. The depression at the base of the dens in *Lynx* is replaced by an elevation in *Felis*. In *Lynx* the dens is heavier, the cranial tip of the neural spine is usually more expanded, and the spine is rougher along the free border.

Last Five Cervical Vertebrae.—The most obvious difference in these vertebrae is the proportional increase in the length of the neural spines of *Lynx*. In other respects, these vertebral series are alike.

Last Three Thoracic Vertebrae.—In *Felis*, the tips of the neural spines are much less knobbed. The spines of *Lynx* are proportionately larger in craniocaudal measurement, particularly in the basal half. These differences indicate a larger epaxial musculature in *Lynx*. These muscles largely determine the springing ability. It would follow, then, that the articular facets would be proportionately increased in *Lynx*, a condition found to be present. In other respects, this series of vertebrae is the same in both animals.

Lumbar Vertebrae.—The lumbar vertebrae of *Lynx* differ from those of *Felis* in that the pseudotransverse processes project more laterad and project less ventrad. In other respects they are similar.

Sacral Vertebrae.—The iliosacral joint of *Lynx* is proportionately larger and the neural spines of the sacrum are better developed. Measurements show that the maximum interauricular breadth was 82 per cent of the central length in five specimens of *Lynx* and 111 per cent in four of *Felis*. In *Felis* the sacrum is concave ventrally, while in *Lynx* there is almost no concavity. In *Lynx* the sacrum diminishes markedly in breadth caudally, while in *Felis* the decrease is much less pronounced, a feature undoubtedly correlated with the reduced size of the tail in *Lynx*. The 1st sacral vertebra is proportionately enlarged in *Lynx*.

Scapula.—In *Lynx* the coracovertebral angle is much less pronounced than in *Felis*. The infra- and supraspinous fossae are approximately the same in both animals. The acromion process of *Felis* is generally more spine-like and forms a less distinct angle with the major portion of the subscapular fossa than in *Lynx*. This latter condition is true also of the fossa for teres major. The coracoid process is larger proportionately in *Lynx* and

is usually less curved. The proportional sizes of the scapulae are about the same. The maximum width is 59 per cent of the length in *Lynx*; 60 per cent in *Felis*. The length, measured from the center of the glenoid cavity to the glenovertebral angle, is 33 per cent of the "arm" length (humerus plus radius) in *Lynx*; 34 per cent in *Felis*.

Clavicle.—The clavicle of *Felis* is actually, as well as proportionately, larger and is 23 per cent of the length of the radius as compared with 12 per cent in *Lynx*. This comparison is justifiable since it will be shown that the radii of these two animals are of the same proportional length. The reduction of the clavicle in *Lynx* indicates a greater restriction of movement to the forward-backward plane. This restriction usually accompanies increased springing ability and its reduction indicates a lack, or at least a diminution of climbing abilities. There is no great difference in the configuration of the clavicles. It was noted, however, that the clavicle was sometimes decidedly curved in *Felis*, but not in *Lynx*.

Humerus.—Assuming the functional length of the "arm" to be the sum of the lengths of the humerus and the radius, it was found that in both species the humerus was 52 per cent of the arm. In configuration, however, there are numerous small differences. It appears that the distal condylar surfaces of the humerus of *Lynx* are slightly shifted laterad as compared to *Felis*, and therefore, the medial epicondyle seems more pronounced in *Lynx*. The condylar width was 74.5 per cent of the epicondylar width in *Lynx*, and 70 per cent in *Felis*. The olecranon fossa is deeper and narrower in *Lynx*, the ridge forming the lateral edge of the fossa is more pronounced distally, the distal end of the shaft is expanded more abruptly, and the curvature of the shaft is more pronounced. This is true of both the craniocaudal and the lateromedial curvatures. The greater tuberosity is lower, broader, and generally heavier in *Lynx*, its long axis transects the craniocaudal plane of the limb at a greater angle, and the lesser tuberosity is heavier and less pointed. As a whole, these differences indicate a proportionately greater musculature in *Lynx*.

Radius.—The radius was 48 per cent of the "arm" in both species. The styloid process of the radius is ordinarily better developed in *Lynx*. This condition is correlated with the reduced clavicle and tends further to limit the rotation of the forearm in *Lynx* and restrict movement to the craniocaudal plane. The shaft of the radius is generally more flattened in *Lynx*, suggesting a closer application of the radius to the ulna. This, too, restricts rotation of the arm. In *Lynx*, the increase in size of the small fossa proximal to the bicipital tubercle further substantiates this evidence. In other respects these bones are similar.

Ulna.—In both animals the ulna was 60 per cent of the length of the "arm" and differs little in configuration. In *Lynx* the shaft is usually flatter, the olecranon process slightly larger, the proximal half of the caudal edge of the ulna more expanded, and the small tubercle that articulates with the radius more prominent.

Hand.—An examination of four specimens of each species showed that the length of the hand was 39 per cent of the length of the arm in *Lynx*; 36 per cent in *Felis*. The hand measurement did not include the distal phalanx since this is normally retracted and does not enter into the functional length of the appendage. In view of other findings, I am inclined to believe this indicates a lengthening of the hand of *Lynx*.

Scapholunar.—In *Lynx* the articular surfaces of this bone are better defined, the nonarticular areas are more roughened and pitted, and the protruding processes are relatively heavier.

Cuneiform.—This bone exhibits great variation in different specimens and also in the same individual, but shows no essential differences in *Felis* and *Lynx*.

Pisiform.—In *Lynx*, the lateral surface is much more prominent and deeply pitted but quite smooth in *Felis*. The medial and distal surfaces are strongly separated in *Felis*, but not in *Lynx*. The dorsal articular facet and the caudal surface are proportionately larger in *Lynx*. These differences point to an increase in the function of the pisiform in *Lynx*. Since this function is that of a lever to extend the hand, the significance of this fact may be correlated with a greater striking power of the hand, and with greater springing and running ability.

Greater Multangular.—No differences observed in the two animals.

Lesser Multangular.—Flatter in *Felis* than in *Lynx*, but in other respects the same in both animals.

Capitate.—In *Felis* the distal surface of the capitate is more constricted in the transverse axis. In *Lynx* the dorsomedial angle of the body bears a proportionately larger articular facet and the lateral and medial surfaces are more deeply pitted than in *Felis*.

Hamate.—In *Lynx* the dorsal portion of the distal surface and the ventral portion of the proximal surface are proportionately wider than in *Felis*. Lateral and medial articular facets are better defined in *Lynx*.

Metacarpus.—The metacarpus is almost identical, except for size, in the two species. In *Lynx* the first metacarpal is thicker in proportion to its length. In general, the remaining bones of this group differ only in that the surfaces, facets, etc., are more prominent in *Lynx*.

Phalanges.—The phalangeal formulae are the same. The individual bones do not differ in any essential respect. The claws are proportionately longer and more tapering in *Lynx*.

Pelvic Girdle.—In general the conformation of the innominate is the same in both species. The postacetabular length was 63 per cent of the preacetabular length in *Felis*; 69 per cent in *Lynx*. Further analysis showed that the post-sacral length of the ilium was 67 per cent of the presacral length in *Lynx*, but 106 per cent in *Felis*. These measurements were taken from the center of the acetabulum to the center of the sacroiliac joint and from the center of the joint to the tip of the ilium respectively. This shows an increase in the presacral length in *Lynx* and a decrease in the post-sacral. Howell (1932: 519) found a similar condition in some saltatorial rodents. He suggests that in rodents, the saltatorial habit is directly correlated with a decrease in the post-sacral length of the ilium. He further suggests that a proportionately longer presacral length would be conducive to greater efficiency of the passive musculature of the hip. Since the greatest stress is applied to these muscles when the animal springs, *Lynx* then exhibits a greater specialization for jumping than *Felis*. It should be noted in passing that in two sub-adult specimens of *Lynx* examined the post-sacral measurement was 72 per cent of the presacral, indicating the proportion found in *Felis* to be the more primitive condition.

The lateral surface of the ilium is more concave in *Lynx*, which substantiates the thesis that the passive musculature of the hip is proportionately greater in that species. The lip of the acetabulum is slightly more expanded in *Lynx* than in *Felis*, probably because of the greater stress in jumping. In *Lynx*, the articular surface (the wall) is further separated from the floor of the acetabulum, the obturator foramen is more elongated, and the spine of the ischium is usually better developed. The shape of the pelvic cavity and the angle of the pelvis with the sacrum do not differ in these two animals. The epiphyseal structures are proportionately larger in *Lynx*, but since these structures depend largely upon the age of the animal, this comparison is of doubtful value.

Femur.—In *Felis*, the femur was 49 per cent of the length of the leg; in *Lynx*, 51. While this difference is small, it is so constant in various specimens that it must be considered significant. The leg was considered as the sum of the femur and the tibia. It seems worthy of mention that the femur of the sub-adult *Lynx* was 55 per cent of the leg.

The dorsal surface of the neck of the femur is thicker and more nearly straight in *Lynx*, the latter due principally to an increase in the diameter of the neck. These facts again show that in *Lynx* the hip region is proportionately larger. In *Lynx* the greater trochanter is more angular and the trochanteric fossa deeper and more cone-shaped, the lesser trochanter is larger and more knobbed, and the lateral branch of the linea aspera is better developed. In *Lynx* the shaft is subcylindrical whereas in *Felis* it is almost a true cylinder. The intercondyloid fossa is deeper, narrower, and rougher, the medial condyle extends further distad, and the caudoproximal portion of the surface of the lateral condyle is less concave in *Lynx*.

Patella.—Differs in no significant respect.

Tibia.—The femur of *Lynx* is comparatively longer in proportion to the length of the leg and the tibia is comparatively shorter. The ratio of length of tibia to length of femur is 95 in *Lynx* and 102 in *Felis*.

The spine of the tibia is larger in *Lynx*, the lateral tuberosity extends farther caudad and its condylar surface appears to be flatter. The facet for articulation with the fibula, as well as its supporting tubercle, is relatively larger in *Lynx*, and the popliteal notch is usually larger. The shallow groove which lies in its floor in *Lynx* is all but lacking in *Felis*. The concavity of the proximal portion of the lateral surface of the shaft is more pronounced in *Lynx*. The distal portion of the bone shows no differences in the two.

Fibula.—The fibula does not differ essentially. In general, however, it may be stated that articular surfaces, crests, fossae, depressions, etc. are more pronounced in *Lynx* as might be expected.

Tarsus.—As a whole, the number of bones and their arrangement is the same in both species. In both, the foot was 52 per cent of the leg length. While these percentages may not be indicative of the true proportion, they are accurate from a comparative standpoint. When the length of the hind limb is expressed in terms of the front limb, the former is 124 per cent of the latter in *Lynx* and 120 per cent in *Felis*. Analysis of the data furnished by the femur, tibia, humerus, and radius shows that the increased length of leg in *Lynx* is due to a lengthening of both tibia and femur, chiefly the latter.

Astragalus.—In *Felus* the neck of the astragalus is more constricted than in *Lynx*, and the neck arises from the body at a less acute angle. As a general rule, the trochlear groove is shallower in *Lynx*. There are several minor differences on the ventral surface of the bone. These are chiefly related to the ligamentous and tendinous attachments. The large ventral groove of the body is usually better defined in *Lynx* and the ventral pit of the neck is proportionately deeper.

Calcaneous.—If we can accept the thesis that *Lynx* is better adapted for springing than *Felis*, the calcaneus should show some evidence of this. Since the greatest stress is applied to the calcaneous in a vertical plane, it should be comparatively larger in this dimension in *Lynx*. This appears to be the case although attempts to measure this difference were not successful. The proximal surface of the caudal process has a long transverse axis in *Felis* and a long vertical axis in *Lynx*. In *Felis*, the distal articular surface is more concave.

Scaphoid.—Does not differ essentially, although generally more angular in *Lynx*.

Cuboid.—In *Felis* the ventral surface of the cuboid is not so distinct as a separate surface as it is in *Lynx*. Other minor differences are of no great importance.

Lateral Cuneiform.—In *Felis* the distal portion of the lateral surface is shallowly excavated, while that of *Lynx* is almost grooved. Therefore, the lateral edge of the distal surface is deeply emarginate in *Lynx*, but broad and shallow in *Felis*. The peroneal hook is stronger, more swollen, and more angular in *Lynx*.

Intermediate Cuneiform.—This bone shows no noteworthy differences.

Medial Cuneiform.—The proximal surface of this bone transects the long axis of the tarsus at a greater angle in *Lynx* than in *Felis*. Otherwise, the bones are the same.

Metatarsus.—In *Felis* the first metatarsal is less triangular than that of *Lynx*. The remainder of the metatarsal bones differ in that the crest of the head extends farther proximad in *Lynx*. Usually the lateral curvature of the fifth is more pronounced in *Felis*.

Phalanges.—They show no difference worthy of mention. The phalangeal formula is the same in both.

CONCLUSIONS

1. With the exception of the difference in the number of teeth and the length of the tail, *Lynx* differs from *Felis* chiefly in the summation of many small differences.

2. The facial region is more massive in *Lynx*, as befitting its vigorously predatory mode of existence, and the facial plane is more abrupt.

3. There is a loss of the 2nd upper premolars and a marked proportional increase in the size of the canines in *Lynx*. Since the carnivorous diet has occasioned a reduction in the number of teeth of cats, the loss of the 2nd premolars in *Lynx* is evidently a further specialization.

4. In general, the ridges for the attachment of muscles on the skull are more prominent in *Lynx* than in *Felis*. The mandible is deeper and straighter in *Lynx* and its articulation is slightly modified to permit wider opening of the jaws.

5. The sternum and ribs show no essential differences.

6. With the exception of the caudals, the vertebral series are of the same proportional length in these two animals. The caudal series shows a reduction in the number and size of the vertebrae in *Lynx*.

7. The sacrum of *Lynx* presents a proportionately larger first sacral vertebra and the iliosacral joint is heavier.

8. The neural spines and other processes for the attachment of the epaxial musculature are relatively larger in *Lynx*. All of the differences encountered in the vertebral column point to a greater dorsal musculature in *Lynx* and probably a greater springing ability.

9. The elements of the front girdle and appendages are of the same proportional size except for the clavicle, which is much reduced in *Lynx*. Small differences in the configuration of this group of bones indicate that the anterior limb of *Lynx* is more nearly confined to the craniocaudal plane of movement than that of *Felis*.

10. There is an increase in *Lynx* of the postacetabular length of the innominate. At the same time there is a shortening of the postsacral length of the ilium.

11. There is a slight but constant difference in the length of the hind limb as compared to the front limb in *Lynx*. This is due to an increase in both femur and tibia, chiefly the former. The femur is longer than the tibia in *Lynx*, but shorter in *Felis*.

12. There is no great difference in the hind foot of *Lynx* and *Felis*.

13. The skeleton of *Lynx* is less subject to morphological variations than that of *Felis*.

14. As a whole, the osteology of *Lynx* and *Felis* shows that *Lynx* is better adapted to springing than *Felis*. It seems reasonable to correlate this with the increased difficulty of obtaining food in the desert environment. Dentition and jaw adaptations demonstrate that *Lynx*, at least in some respects, resembles the extinct saber-toothed cats.

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POCKET GOPHERS (THOMOMYS) OF THE DAVIS MOUNTAINS, TEXAS

By William B. Davis and Helmut K. Buechner

In 1902, Bailey described the small pocket gopher from the head of Limpia Creek, elevation 5,500 feet, Davis Mountains, Jeff Davis County, Texas, under the name *Thomomys fulvus texensis*. In 1934, Nelson and Goldman found evidence that *Thomomys fulvus* and *Thomomys bottae* intergrade and placed all forms formerly recognized as races of *fulvus* in the species *bottae*. The Davis Mountains gopher then became known as *Thomomys bottae texensis*. As one result of field work conducted in the Davis Mountains by a party from the University of Michigan, Blair (1939) removed *texensis* from the species *bottae* and placed it with the Mexican species *Thomomys umbrinus* because of its "small, rounded skull, small size, and weak forefeet." In the same paper (p. 2) he described a new race, *Thomomys bottae limpiae*, on the basis of four specimens from the mouth of Limpia Canyon, one mile north of Fort Davis.

To throw additional light on the relationships of *texensis* and the new race *limpiae*, field parties from the Department of Fish and Game, Agricultural and Mechanical College of Texas, collected 38 specimens of *Thomomys* from Limpia and upper Madera canyons, as follows; mouth of Limpia Canyon, 1 mi. N Ft. Davis, 4,800 ft. (type locality of *limpiae*), 13; Limpia Canyon, 5 mi. E Mt. Livermore (Baldy), 5,600 ft. (type locality of *texensis*), 11; Madera Canyon, 14 mi. NW Ft. Davis, 6,000 ft., 10; Madera Canyon, 3 mi. N Mt. Livermore, 6,500 ft., 4. Intensive search revealed no *Thomomys* between the type localities of *texensis* and *limpiae*, a distance of about 13 miles; the area was occupied by the larger *Cratogeomys castanops lacrimalis* Nelson and Goldman. This large gopher occurred almost continuously in Limpia Canyon from Ft. Davis to a point 7.5 miles east of Mt. Livermore, at an elevation of 5,300 ft.

STATUS OF THOMOMYS TEXENSIS

Number of pectoral mammae.—Bailey (*op. cit.*) states that *T. texensis* is characterized by the presence of four pairs of mammae (two pectoral and two inguinal). In two of the female paratypes examined by Blair, one had two pairs of pectoral mammae; the other, one pair. In the collection made by Davis, one pair of pectoral mammae was found in each of four topotype females. In neighboring territory one female was found with two pectoral pairs; two others with one pair. This would indicate that *texensis* usually has only one pair of pectoral mammae. Data on the number of pectoral mammae in the populations here under consideration are summarized in Table 1. All three of the populations contained individuals with one or two pairs of pectoral mammae. The populations at higher elevations (5,500 to 6,500 feet) tend to have one pair, whereas those at the lower elevation (4,700 feet) tend to have two pairs. These marked tendencies may indicate that speciation is taking place, but the overlap suggests that the process is not yet completed, and that on the basis of this character the

two populations belong to the same species, since free interbreeding would probably occur if natural contact were established.

Anterior base of zygoma.—In shifting *texensis* from *T. bottae* to the species *T. umbrinus*, Blair used the small, rounded skull, small size, and weak forefeet as diagnostic characters. Examination of *T. umbrinus orizabae* Merriam, a race occurring not far from the typical race *T. u. umbrinus* (Richardson), showed most of them to be much larger than *texensis*, rather than smaller. In comparing *umbrinus* with *bottae*, it is evident that some races of *umbrinus* are much

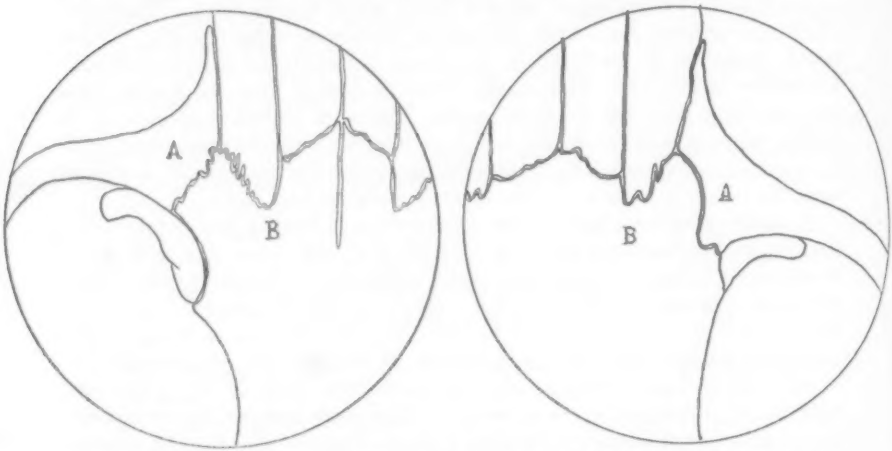

FIG. 1. Dorsal view of skulls of *Thomomys bottae* (left) and *T. umbrinus* (right), showing margin of zygoma (A) at juncture with frontal (B).

larger than some races of *bottae*, and *vice versa*. Size, therefore, is not a diagnostic character in distinguishing between these two species.

As pointed out by Bailey, the margin of the anterior base of the zygoma where it meets the frontal provides a good diagnostic character of *umbrinus*. In *umbrinus* it is definitely concave or emarginate in outline (fig. 1); in *bottae*, convex. Examination of 27 specimens of *umbrinus* and 67 of *bottae* shows this character to be constant for each species with no overlap. All specimens taken from the four populations under consideration in the present study possessed the convex type of margin at the anterior base of the zygoma. On the basis of this character, then, the race *texensis* is referable to *T. bottae*, to which *limpiae* also belongs.

STATUS OF THOMOMYS LIMPIAE

Having established that *texensis* and *limpiae* belong to the same species, the next consideration is the relationship between the two. Each is based on specimens taken from populations that are separated by a distance of about 13 miles and by an altitudinal difference of 800 feet (5,500–4,700 feet). Both occur in Limpia Canyon, *texensis* being located at the head of the canyon at the higher elevation. The two populations are separated by an area inhabited by *Crato-*

geomys, which seem to have invaded the region from the south and east, and separated the two populations of *Thomomys* that were then in contact with each other. That these *Thomomys* formed at one time one large freely interbreeding population is suggested by an analysis of measurement data, as well as similarity in color and the occurrence of either one or two pairs of pectoral mammae.

Biometric analysis of measurement data.—In an attempt to determine whether *limpiae* is a valid race, the measurements were subjected to biometrical analysis. We have followed the convention adopted among ornithologists (Mayr, 1942) that a group of populations may be recognized as a subspecies when at least 75 percent of the individuals can be recognized accurately.

It was postulated that if all the size characters showed no significant differences between populations, the individuals belonged to the same race, the high variability and intergradation of the measurements precluding taxonomic distinction. However, where significant differences do occur, the characters involved cannot

TABLE 1.—*Number of pectoral mammae in pocket gophers*

	Thomomys bottae texensis (TYPE LOCALITY)		*Thomomys bottae texensis* (14 MI. NW OF FORT DAVIS)		*Thomomys bottae limpiae* (TYPE LOCALITY)	
	Number of specimens	Number of mammae	Number of specimens	Number of mammae	Number of specimens	Number of mammae
Blair	1	2 prs.	—	—	3	"Usually 2 prs."
	1	1 pr.	—	—	—	—
Davis	—	—	1	2 prs.	2	2 pr.
	4	1 pr.	2	1 pr.	1	1½ pr. (3 mammae)
					1	1 pr.

be used as infallible criteria for designating races without close examination of the data. In spite of low variability and significant differences, the intergradation may overlap to such an extent that the populations cannot be considered genetically and taxonomically different.

The measurement data which were analyzed are recorded in Table 2. A superficial examination reveals that the population at the type locality of *limpiae* averages larger than that at the head of the canyon, and that the females of both populations are usually smaller than the males. Critical examination of individual variation, however, shows that the two populations intergrade somewhat, the degree of intergradation varying with the size character examined.

Analysis of variance was applied to each of the size characters to determine significant differences between the two populations and also between sexes. In all cases exept one, there were no significant differences between sexes, although females averaged smaller than males. The one exception was that the rostral length of females of *texensis* averaged smaller than that of the males. This is an interesting observation, but it has no influence on the conclusions to be made from the total analysis. Since there were no significant differences between sexes, with one exception, both sexes enter into the analysis between popula-

tions. Six individuals from one population and eleven from the other are probably adequate samples, in view of the small amount of individual variation encountered.

TABLE 2—*Measurements (means and extremes in millimeters) of Thomomys from the Davis Mountains, Texas*

LOCALITY	NUMBER OF SPECIMENS	TOTAL LENGTH	LENGTH OF TAIL	LENGTH OF HIND FOOT	BASILAR OF HENSEL	ZYGOMATIC BREADTH	MASTOID BREADTH	UPPER DIASTEMA	PALATILAR LENGTH
				Males					
4800 ft.	3	207 (177–221)	61 (48–71)	28.1 (25.3–29.5)	32.5 (30.7–33.6)	23.3 (21.6–24.3)	18.7 (17.6–19.3)	13.1 (12.4–13.7)	21.4 (19.8–22.9)
5600 ft.	5	197 (180–215)	67 (60–77)	25.7 (23.7–27.0)	30.6 (28.4–32.0)	21.3 (19.5–22.8)	17.3 (16.2–18.0)	12.3 (11.0–13.5)	20.5 (18.9–20.9)
6000 ft.	2	191 (182–201)	57 (54–60)	25.0 (23.2–26.7)	31.5 (30.6–32.3)	21.9 (21.2–22.6)	17.6 (16.5–18.7)	12.9 (12.3–13.4)	20.6 (20.2–21.0)
6500 ft.	0								
				Females					
4800 ft.	3	201 (192–208)	66 (60–69)	27.3 (26.4–27.7)	31.1 (30.5–31.4)	22.5 (22.0–22.7)	18.4 (18.0–18.9)	12.7 (12.5–12.9)	21.1 (21.0–21.2)
5600 ft.	6	194 (180–205)	66 (55–73)	25.8 (24.3–27.8)	29.0 (27.6–30.0)	20.7 (19.9–22.1)	16.9 (16.2–17.8)	11.5 (10.9–11.8)	19.2 (18.0–20.6)
6000 ft.	8	184 (160–214)	52 (45–66)	25.1 (23.5–29.8)	28.1 (25.8–29.5)	20.2 (19.0–21.0)	16.6 (15.5–17.0)	11.0 (10.0–11.6)	18.3 (16.7–19.0)
6500 ft.	3	187 (180–191)	59 (55–61)	24.5 (24.2–25.5)	29.1 (28.2–29.6)	20.9 (20.5–21.2)	17.0 (16.4–17.3)	11.3 (10.9–11.7)	19.4 (18.7–19.9)

TABLE 3.—*Means and mean differences between texensis and limpiae*

	TOTAL LENGTH	LENGTH TAIL	LENGTH HIND FOOT	BASILAR HENSEL	ZYGO-MATIC BREADTH	MASTOID BREADTH	UPPER DIASTEMA	PALATAL LENGTH
Means for *T.b. limpiae*	203.6	63.5	27.7	31.8	22.9	18.6	12.9	21.3
Means for *T.b. texensis*	195.5	66.5	25.8	29.8	21.0	17.1	11.9	19.9
Mean difference	8.1	3.0	1.9*	2.0**	1.9**	1.5**	1.0*	1.4*

*Significant.
**Highly Significant.

Six of the twelve characters were found to be significantly different between the two populations, four of them having highly significant differences. In order of importance these are: mastoid breadth, zygomatic breadth, basilar length of Hensel, upper diastema, palatilar length, and length of hind foot. A summary of the means and mean differences of various characters is presented in Table 3.

Among the twelve size characters, six showed no significant difference be-

tween populations. These were total length, length of tail vertebrae, length of nasals, interorbital constriction, alveolar length of upper tooth row, and rostral length. Attention was directed toward careful examination of the six signifi-

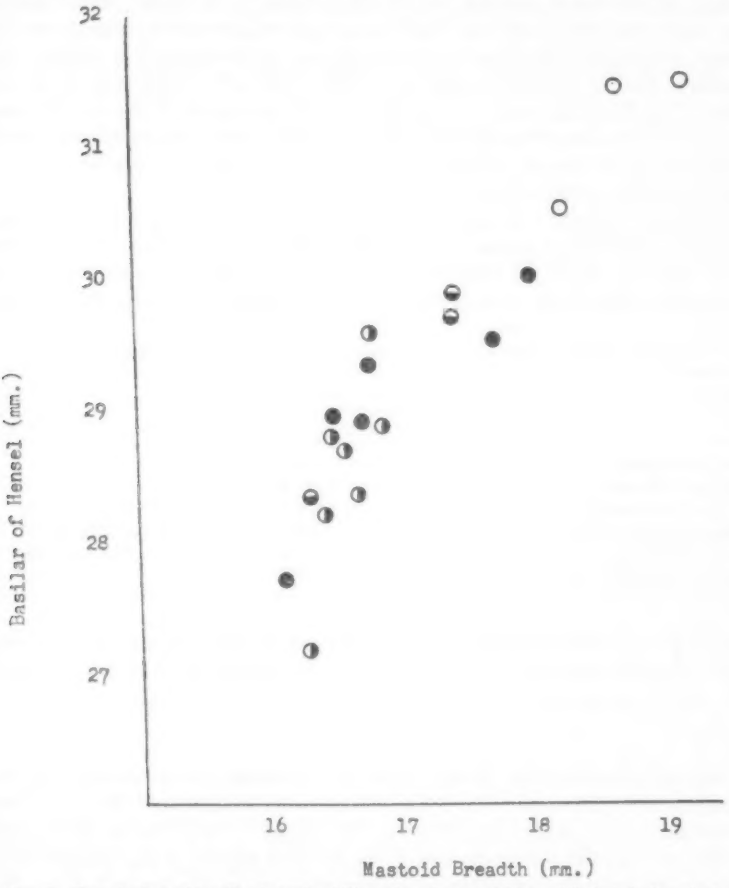

FIG. 2. Correlation of basilar length of Hensel and mastoid breadth (adult females).
○ *Thomomys bottae limpiae* (type locality)
● *Thomomys bottae texensis* (type locality)
◑ *Thomomys bottae texensis* (14 mi. NW of Ft. Davis)
◒ *Thomomys bottae texensis* (3 mi. N of Mt. Livermore)

cantly different characters. Any justification for establishing the two populations as separate subspecies should be found among them.

To determine whether the two populations are worthy of taxonomic recognition, correlation charts were constructed using the following measurements: (1) basilar of Hensel and mastoid breadth (fig. 2), (2) basilar of Hensel and zygo-

matic breadth, and (3) upper diastema and palatilar length. These charts were made for both male and female specimens. In addition, measurements of length of hind foot were plotted to determine the degree of overlap in this character. It was found, through a study of the correlation charts, that females are less variable in size characters than males and therefore more reliable for separating subspecies. Analyses of the correlation charts revealed a definite segregation of the populations on size characters. The charts also showed the presence of a well-defined cline. Along the cline certain values of size may be chosen to separate *texensis* from *limpiae* (see Table 4). This demarcation holds true with at least 75 percent of the specimens at hand, and also conforms with the measurements published by Blair (*op. cit.*).

Although forming a distinct cline, the races *texensis* and *limpiae* segregate into two well-defined groups, and on the basis of the evidence presented here, both must be considered valid subspecies. It is entirely possible that the sizes of samples taken from each population are not sufficiently large to represent a

TABLE 4.—*Values of size characters used in distinguishing texensis from limpiae*

	FEMALE			MALE		
	texensis		*limpiae*	*texensis*		*limpiae*
Mastoid Breadth	−	18.0	+	−	18.0	+
Basilar of Hensel		30.0			32.0	
Zygomatic Breadth		21.0			Too variable	
Length of Hind Foot		26.0			27.5	
Upper Diastema		12.0			Too variable	
Palatilar Length		20.5			Too variable	

true picture of the conditions as they exist in nature. Larger samples might show a greater degree of overlap among the size characters, and the intergradation may be so great as to prevent taxonomic recognition of separate races.

SUMMARY

Originally described by Bailey (1915) as *Thomomys fulvus texensis*, and later transferred to the species *T. bottae* (Nelson and Goldman, 1934), the Davis Mountain pocket gopher was placed in the species *T. umbrinus* by Blair (1939). On the basis of the convex nature of the anterior margin of the zygoma where it meets the frontal, this subspecies is here replaced in the species *bottae*. Blair also described *T. bottae limpiae* as new, with the type locality 1 mile north of Fort Davis. Since both races occur in the same canyon, separated by a distance of only 13 miles, it was thought they might be the same. But through biometrical analyses and correlation charts, it was shown that the race *limpiae* can be separated from *texensis* with an accuracy of 75 percent or greater.

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GENERAL NOTES

NOTES ON DIPODOMYS ORDII RICHARDSONI

Late in the summer of 1938 I captured, and kept as pets, several individuals of *Dipodomys ordii richardsoni*. Almost nightly during the fall and winter of that year these delightful little mammals were allowed to roam about the floor of my garage where I was able to observe many of their habits and some of the behavior which presumably occurs in the wild. A recounting of the observations may serve to shed some light upon the life history of this kangaroo rat. Three individuals in particular furnished most of my data. One or two others were kept for a time but escaped.

All of the animals were taken about 7 miles north of Amarillo, Potter County, Texas, in a sandy drainageway with a raw sand wash down the channel. The burrows at which the rats were trapped were located in the edges of the wash. The dominant vegetation here was *Sporobolus aeroides*, and there was an abundance of forbs—notably, *Amaranthus blitoides*, *Helianthus annuus*, *Euphorbia albomarginata*, *Ambrosia sp.*, and *Desmanthus illinoensis*. *Cenchrus sp.* was common. The habitat was also occupied by a *Peromyscus*, a *Sigmodon*, a *Reithrodontomys*, none of which I have yet identified, and the black-tailed prairie-dog, *Cynomys ludovicianus*. Some of the other important animals occurring in the drainageway or nearby were prairie rattler, *Crotalus confluentus* (seen), coyote, *Canis latrans ssp.* (tracks), house cat, *Felis catus* (seen), and Swainson hawk, *Buteo swainsoni* (seen).

On September 19, 1938, I captured an adult male kangaroo rat at this location, and on the 25th an adult male and female. These were kept in individual cages, a description of which was published recently (Allan, Philip F., Jour. Mamm., vol. 25, pp. 403–404, 1944).

Foods.—The pouches of a kangaroo rat taken August 21, 1938, contained 529 seeds of *Amaranthus blitoides*. The three pet rats were offered nightly an equal choice of seeds of *Eriogonum annuum*, *Schedonnardus paniculatus*, *Bouteloua gracilis*, *Bouteloua curtipendula*, *Andropogon scoparius*, *A. hallii*, *Elymus canadensis*, *Sporobolus cryptandrus*, *Sorghastrum nutans*, *Panicum virgatum*, *Calamovilfa longifolia*, *Buchloë dactyloides*, *Agropyron smithii*, *Hordeum pusillum*, *Hilaria jamesii*, and *Eragrostis sp.* In addition, at odd intervals, they were offered such foods as pecans, green heads of *Echinochloa crus-galli*, *Sorghum halepense*, *Cenchrus pauciflorus*, *Amaranthus blitoides*, *Chenopodium sp.*, *Bouteloua gracilis*, and *B. curtipendula*, and pods of *Desmanthus illinoensis*. Whenever a single food was selected 5 times in succession the containers were changed about. At first *Hilaria jamesii* was selected most frequently, followed by *Panicum virgatum* and *Hordeum pusillum*. Ultimately, however, equal second choice was shown for *Andropogon hallii* and *Bouteloua gracilis*, *Panicum* and *Hordeum* declining in importance. *Andropogon scoparius* was high in the list of preferences, and most of the other grasses were sampled from time to time. *Bouteloua curtipendula*, *Elymus canadensis*, and *Sporobolus cryptandrus* were least frequently chosen. These observations do not necessarily mean that these are the foods that kangaroo rats would select in the wild. All of the green foods were accepted to a limited extent. With

the exception of *Amaranthus*, in which the petioles were taken, only seeds of the green plants were selected. The seeds of *Desmanthus illinoensis* were rapidly removed from the pods and stuffed into the pouches of the rats. On the night of August 29 one of the kangaroo rats captured and quickly killed a large cricket, which was later partially eaten.

Water.—All of the kangaroo rats readily drank water. Usually they would go to water immediately upon being released from their cages. Drinking was accompanied by a lapping or sucking sound. Investigation showed that water was scooped into the mouth with the forefeet. Following a period of drinking, the head was extended, and the mouth parts rubbed upon the floor. One rat stayed at water, drinking at intervals, for about three minutes.

Fighting.—Fighting ordinarily did not seem to be serious, although on one occasion when mating was taking place one male very savagely attacked another, and it was necessary to return the attacked male to his cage to prevent serious damage. During the frequent skirmishes held nightly the two combatants faced each other with heads held low. When one found an advantage, imperceptible to me, it ran past the other, kicking sidewise. Sometimes one leaped over the other and kicked downward, or sprang at the other's head, kicking forward. The latter blows usually were fended by the opponent. Only rarely did fighters spar with forefeet. Most of the attempts to bite were directed at the opponent's tail. A threat by one rat against another evoked a "tooth-chattering" sound, and flight by a cowed opponent was accompanied by a faint chuckling noises or squeaky snorts.

Dominance.—The small of the two males dominated the other, as well as the female. The female dominated the large male. Since the smaller male was captured earlier and had frequented the garage floor first, it is possible that he considered it his territory. For a short period when mating was taking place the female dominated both males, but after a few days the small male regained his dominance. Cages were generally inviolate, the owner repelling all intruders.

Orientation.—Each Kangaroo Rat quickly learned the position of its cage upon the garage floor, and when observations were over for the evening a little "shooing" would send each to its respective home. If cages were moved there was slight confusion, but errors were quickly rectified. In making food selections the shifting of choice foods resulted in an induced error in the rat's next visit. Often a search was made to find the new location of the desired seeds. After a 5 day lapse one of the rats went directly to the location of the water dish, which was always left in the same spot. The small male was the only one to show any exploratory nature. It often made its way into the kitchen, which adjoined the garage, and would have carried its explorations farther if permitted. This individual was the only one of the three that voluntarily sought petting. It would readily hop into my lap, and climb to my shoulder, where it nibbled at the back of my neck. The rats were poor climbers and lacked good balance on narrow ledges.

Mating.—The mating behavior of these kangaroo rats has been described in detail elsewhere (Allan, *loc. cit.*). Mating took place in a box of soil provided for grooming. Coitus of long duration took place frequently after much preliminary chasing and other stimulations between the small male and the female on November 13, 1938.

Sanitation.—My observations coincide with those of other authors in regard to the fondness of kangaroo rats for grooming by sliding and rolling in dust. Unless dusting material is provided the fur of the rat becomes matted and sores frequently develop. The action of the kangaroo rat in dusting is somewhat reminiscent of the movements of a mink. The underparts and sides are slid over the soil quickly with strong pushes of the hind legs. The feet and tail, especially, receive careful grooming.

The cotton nesting material provided for the rats was not kept clean by them. Scats and seeds were intermingled, and the nest became foul if I did not regularly clean it. This observation, however, has little significance as contrasted to conditions in a burrow. Micturation took place outside of the nest, usually in a corner of the cage. Many crystals about 4 mm. long developed in the urine spots within a few hours after drying.

Scats.—A number of scats were measured. They averaged 5.0 mm in length and 2.07 mm in thickness. The range was from 7.0 x 3.0 to 3.0 x 1.5.

Pace.—At the normal traveling gait each hop averaged 94.4 mm. The range was 65 to 130 mm. The highest jumps I was able to record were 17 and 19 inches. Even at what was apparently top speed my kangaroo rats never made long or high leaps, but merely accelerated the rate of their hops and, perhaps, lengthened them somewhat.—PHILIP F. ALLAN, *Soil Conservation Service, Fort Worth, Texas.*

ARMADILLOS ABUNDANT IN KERR COUNTY, TEXAS

The combination of warm weather and plenty of rain in the winter of 1944–45 was favorable for armadillos in central Texas where, apparently, there was a bumper crop as judged from counts of active dens on a large ranch in the Divide country about 40 miles west of Kerrville, Kerr County, and on the Kerrville State Park, 3½ miles south of Kerrville.

From 10:15 a.m. to 11:15 a.m. (suntime), April 19, 1945, in connection with a search for dead deer and wild turkeys, a count of all active armadillo dens was made on a strip approximately 2 miles long and 40 feet wide in the live oak-shin oak grassland of the Divide country. On this count, which embraced approximately 9.7 acres, 13 active dens were observed—a density of 1.3 per acre.

Another count was made between 1:25 p.m. and 5:45 p.m. the same afternoon on a strip approximately 40 feet wide and 9 miles long. On this strip (43.6 acres) 39 active armadillo dens were counted, occurring at the rate of 0.89 dens per acre.

On May 6, 1945, a count was made between 8:55 and 10:00 a.m. in the live oak-savannah on the Kerrville State Park. The area inspected totaled 9.7 acres. Fifteen active armadillo dens were observed—a density of 1.5 per acre.

The armadillo chooses brushy situations rather than open places for its den. Seemingly it does not care what kind of brush or tree it dens under, although in this general locality it appears to prefer thick shin oak brush.

It is uncertain just how the number of active dens is related to the numbr of animals occupying thc dens. According to Taber (Jour. Mamm., vol. 26, pp. 211–226, 1945), one armadillo may have as many as five dens. On the other hand, as many as five armadillos have been found in one den. The dens here recorded were far enough apart so that perhaps it is fair to count each as indicating one armadillo. In a number of instances several separate openings for a single den were observed. These were noted as one den.

The unweighted average of active armadillo dens per acre based on the three counts is 1.23. From these and other observations it appears that one armadillo per acre in favorable places or 640 armadillos to the square mile is a conservative estimate of the living armadillos this year (1945).—WALTER P. TAYLOR, *Texas Cooperative Wildlife Research Unit, College Station, Texas.*

COTTONTAILS BREEDING IN THEIR FIRST SUMMER

In six years of intensive study, two records of female cottontails (*Sylvilagus floridanus mearnsii* Allen) having bred and given birth to young when only a few months old have been noted at the Rose Lake Wildlife Experiment Station, near East Lansing, Michigan.

The first record concerns rabbit no. 15287, a young female caught by hand during hay mowing operations on June 24, 1942. She weighed about 13 ounces, had a hind foot measurement of 68 mm, and an ear measurement of 44.2 mm. The animal was ear-tagged and released at the point of capture. She was subsequently handled and released on September 12, at which time she was lactating, and had increased in weight to 2 pounds, 6 ounces. When recaptured October 1, she was not lactating, but her nipples were prominent and appeared to have been suckled. When autopsied on this date, she was found to have an enlarged uterus containing 6 (possibly 7) haemorrhagic placental scars, three in each horn (with a possible fourth in the left one). Each uterine horn measured 7 mm in width. Her weight at autopsy was about 2 pounds, 12 ounces. There is little question that this animal had given birth to a litter and nursed the young for some time.

Another female, estimated to be about 2 months old, was caught by hand while plowing on May 19, 1943, and ear-tagged no. 15566. At that time she weighed 381 grams (about 13

ounces); the hind food measured 68 mm, the ear, 45 mm. This rabbit was not handled again until shot by a hunter on October 17, 1942. Autopsy revealed that she was lactating at this time and had enlarged nipples. The uterus was examined and three haemorrhagic scars, possibly four, were found. There were three definite scars in the left horn, and a possible one in the right. In width, the uterine horn was 6 mm. This rabbit's weight had increased to 1,487 grams (about 3 pounds, 4 ounces); her hind foot measured 97 mm, the ear, 61 mm.

The possibility of pseudopregnancy was considered, but the presence of haemorrhagic scars in the uterus made it doubtful that this had happened in the above two cases. However, two possible cases of pseudopregnancy in juvenile rabbits were discovered during the course of the hunting season. On November 1, 1942, a female rabbit weighing 1,067 grams was shot and autopsied. The teats were medium-large (3 mm in length) and contained a clear fluid; the uterus was enlarged (5 mm in width) but showed no placental scars or shadowing. From appearances this rabbit may have developed a pseudopregnancy, records of which are not uncommon for domestic hares.

Another observation on November 30, 1942, indicated sexual activity for a juvenile female of the year, but her exact age was not discernible. This animal was definitely of juvenile build and weighed 1,180 grams. The teats were small, but not minute as in normal juvenile rabbits at this time of the year. Upon examination, the uterus was found to be enlarged (6 mm in width) and veined, but containing no visible placental sites.

These observations on the sexual activity of juvenile cottontails are the first such records to our knowledge to be reported for Michigan. Several hundred rabbits were handled subsequently at the Rose Lake station during the years 1943, 1944 and 1945, but no further evidence of this abnormal sexual behavior was found.—MARVIN E. COOLEY, *Department of Conservation, Lansing, Michigan.*

A CALIFORNIA MOUNTAIN LION OBSERVED STALKING

On February 7, 1946, I observed a California mountain lion (*Felis concolor californica*) apparently stalking deer at midday. From near the summit of Whiteacre Peak, elevation 5,100 feet, Ventura County, California, I was watching nine deer grazing at the northeast corner of a meadow which lay about 1000 feet below me on the south slope of a west-running spur. This greenish brown meadow, about a quarter-mile square in area and of about 20 percent slope, surrounded by thick Upper Sonoran chaparral, was the scene of all the observed action. Five small, rounded ridges ran southward from the top of the meadow. There was a southwest breeze at my level. The sky was clear and the temperature was about 60° F.

At 12:40 p.m. I discovered a lion standing motionless in the open about 300 yards downhill from the deer and I watched it constantly, much of the time with binoculars, for the next hour. The cat seemed to be stalking the deer patiently, alternately walking a short distance and stopping for from one to five minutes as if to watch them. In this manner the lion proceeded westward across a dry creek bed and moved about 50 yards up the slope toward the deer, then headed away from them to cross the ridge, then turned and moved up the slope as before, apparently hidden from them by the ridge crest. In like manner, the lion crossed a second ridge, turned, and moved about 100 yards up the slope, then crossed a third and walked almost to the top of the meadow on a level with the deer but about 300 yards to the west of them. For no apparent reason, the lion then descended the slope for about 100 yards and paused (1:20 p.m.). It then recrossed the third ridge and continued eastward until across its own track of some 20 minutes before and finally walked downhill to near the foot of the meadow and sat among some gopher mounds (1:30 p.m.).

Up to this time the deer showed no alarm other than that occasionally some of them seemed to be watching the lion intently. Judging from the wind direction, it appeared that the deer may have had the lion's scent. At about 1:30 p.m. the deer walked into the chaparral at the top of the meadow. The lion twice walked in a small circle and sat again, then walked to the southwest corner of the meadow, and at 1:38 p.m. disappeared into the brush.

In walking, the lion maintained a steady pace of about two steps per second regardless of slope and carried the tail and head low. The maximum count of steps between stops was 19 going uphill and 29 downhill. When stopped, the lion usually stood very still with head high and tail sometimes up to about 45° below horizontal. Frequently the cat sat erect, raising the head as high as it seemed possible; but at least twice it lay flat on the ground, apparently on its side.

At 2:15 p.m. the deer were again grazing in the northeast corner of the meadow and working down the slope. A lion entered the meadow at the southeast corner, apparently lay in the shade of a bush for a few minutes, and then disappeared from view. This meadow may be a frequent hunting ground for lions, as I have observed up to 60 deer there and have often found lion tracks in the vicinity.

Since the lion did not actually attack the deer, I am uncertain if its actions represent the usual method of stalking or if the lion was only mildly interested in the deer on this occasion. The most interesting feature of the actions of the lion was the erect pose when sitting, presumably to keep the deer in view over the intervening ridges.—Carl B. Koford, *Museum of Vertebrate Zoology, University of California, Berkeley, California.*

COLLECTING BATS IN OHIO

A fairly representative series of Ohio bats was obtained for parasitic investigations by modifying the method described by Borell (Jour. Mamm., vol. 18, 1937). The new method was first employed from June 9 through July 29, 1944, in Union County, Ohio. There, in the earlier part of the summer, a number of small natural pools occur in or near second-growth oak-hickory woods. Those located in the woods seemed especially favorable for bat collecting, because large numbers of bats could be seen flying among the trees and were often seen skimming the surface of the water at dusk. The first collecting attempts were made at a pool adjacent to one of the largest woods in the area. A pasture was adjacent to the other side of the pool. Later, when this pool became overgrown with vegetagion, a much smaller pool, located within the woods, was used.

Several soft iron wires about 0.5 mm in diameter were stretched tightly at different angles over the pool, at a height of about an inch above the water. The pool at this time was about 20 feet long by 15 feet wide. The majority of the bats skimmed across the water parallel with the long axis of the pool, and the wires were arranged to bisect their paths. It is necessary to have a pool relatively free from vegetation, in order to secure the bats when they swim out, and also in order that they will have nothing from which they can take off from the water.

In general, about 50 per cent of all bats striking the wires were captured. The method was especially effective early in the season, when the females were heavy with young and apparently had difficulty in recovering from the effect of the contact with a wire. Some of the smaller species, such as *Pipistrellus*, were not so readily captured since they could rise from the surface of the water and often did not attempt to swim out. In no case was there any evidence of injury to the bats.

The bats flew high among the tree tops at dusk, and descended to the surface of the water only when it had become rather dark. From then on, a steady procession came across the surface of the water until about midnight, after which time they no longer skimmed across the water. They were, however, seemingly as abundant as before in the air around the pool. Observations were carried on until as late as 4:00 a.m. without further change in their activities. The animals were apparently undisturbed by lights and activity around the pools, and would fly quite close to persons present.

On June 11, 23 bats were captured, 19 of which were pregnant females; 4 were males. They were as follows: *Eptesicus f. fuscus*, 15; *Lasionycteris noctivagans*, 3; *Nycticeius humeralis*, 3; *Myotis lucifugus*, 2. As many as three bats would be in the water at one time, and it was often difficult to capture all of them. On June 25, 1944, 7 specimens were captured. All were pregnant females except a specimen of *Myotis lucifugus*. They were: *Eptesicus f. fuscus*, 3; *Pipistrellus subflavus obscurus*, 1; *Nycticeius humeralis* 2; *Myotis lucifugus*, 1.

On July 22, the bats began flying at about 9:00 p.m. (wartime) and as long as there was adequate light (to 9:47) they were collected by shooting, during which time 1 male *Nycticeius humeralis*, 1 male *Myotis lucifugus*, and 1 male and 3 females of *Eptesicus f. fuscus* were taken. When it became too dark to shoot, the following were taken by use of the wire: 2 females of *Nycticeius humeralis*, 2 males of *Lasionycteris noctivagans*, 1 male *Myotis lucifugus*, and 5 males and 9 females of *Eptesicus f. fuscus*.

On July 29 collecting was continued, with the following results: *Nycticeius humeralis*, 7; *Eptesicus f. fuscus*, 5; *Myotis lucifugus*, 1; *Pipistrellus subflavus obscurus*, 1. Two of the specimens of *N. humeralis* were immature, very dark in color, and comparable to those in the collection of the Cleveland Museum, collected by Bole and Moulthrop.

It was of considerable interest to find *Lasionycteris noctivagans* and *Nycticeius humeralis* so abundant. Of the former, in addition to 9 specimens collected by the use of wire, 5 more were found under the bark of a dead tree on May 2, 1943, at the same locality. This makes a total of 14 specimens of this species and 16 of *Nycticeius humeralis*. Bole and Moulthrop (Sci. Publs. Cleveland Mus. Nat. Hist., vol. 5, 1942), speaking of *Lasionycteris noctivagans*, state: "it is not uncommon in northeastern Ohio." Of *N. humeralis*, they say: "Evening bats are known from Cincinnati, and from only a few records in the Ohio River Valley, mostly near Cincinnati; but are very rare elsewhere in Ohio." The majority of specimens collected are deposited either in the collection of the Ohio State Archaeological Museum or in in the collection of the Ohio Wildlife Research Unit. No specimens of *Lasiurus b. borealis* were captured although it is known to be a common bat in this area.

I wish to acknowledge the assistance on several of the trips of L. E. Hicks and George H. Breiding of the Ohio Wildlife Research Unit and especially of Carl F. Troesch of Marysville, Ohio.—ROBERT RAUSCH, *Dept. of Bacteriology, Michigan State College, East Lansing, Michigan.*

PLASTIC VIALS FOR STORING SMALL SKULLS

The writer has recently investigated the matter of securing plastic vials for skulls as an improvement over the glass vials ordinarily used.

Thin, transparent, colorless vials made of cellulose acetate, with flattened end and neck threaded for a thin aluminum screw cap, have been found to be very satisfactory. A cap goes on with a single turn. Such a vial, having an outside diameter of one inch and a length of two inches, weighs, with cap, less than four grams. A similar glass vial, minus cork, weighs about 12 grams, or three times as much. The former, in this size and with cap, costs about three times as much as glass vials of the same dimensions per thousand. I have found this size useful for *Microtus* skulls and others in size ranging up to the smaller races of *Tamiasciurus*. For shrews, *Peromyscus*, etc., a vial $\frac{5}{8}$ inch in diameter by $1\frac{3}{4}$ inches long is very satisfactory. This small size is very light in weight and currently costs, with caps, only about a third more per thousand than glass vials of similar size and with corks.

The advantages of the plastic vials are that (1) they are unbreakable, (2) they are very light—a matter of importance when many are kept in a tray, and (3) covers do not come off, while corks come out of glass vials if not inserted tightly. The plastic vials are advertised as chemically inert, except in connection with cellulose solvents and strong acids and alkalies. They are now available on order in diameters from $\frac{1}{2}$ to $1\frac{1}{4}$ inches and in any length up to 5 or 6 inches. They may be ordered with lettering on them, such as name of collection or museum. They can be had with curled rim or neck, for inserting cork, rather than threaded neck for cap, while the other end may be round (test tube style) or flat.

Since these vials are light and unbreakable, the writer uses them for a number of purposes. A few serve as containers for insect pins and needles in my collecting kit. Others are used for storing buds, seeds, fruits, scats, small bones, and other material for the permanent collection or for class use. They are satisfactory in the field for small alcoholic or formalin specimens, although it seems best to transfer such material to glass containers for permanent storage.

For small skulls, perhaps even better than vials would be transparent plastic boxes with

slip-on covers. These would not roll in a tray. While such are reportedly now available, as yet I have not seen them.—RALPH S. PALMER, *Dept. of Zoology, Vassar College, Poughkeepsie, New York.*

SYNAPTOMYS COOPERI IN SOUTHWESTERN VIRGINIA

Inasmuch as the bog lemming is regarded as an uncommon mammal in the Alleghanies, the following data seem worthy of record. Three specimens of *Synaptomys cooperi stonei* Rhoads were taken by the writer in late August 1945 near the Mountain Lake Biological Station in Giles County, Virginia, on the slope north of Bear Cliffs on Bald Knob Ridge, at about 4,000 feet elevation. Several hundred feet lower, where Little Stony Creek flows westward, are scattered treeless areas bearing the local name "Little Meadows". In one of these openings is a cranberry bog. The opening in which the lemmings were taken lies perhaps three-quarters of a mile west of the cranberry bog.

On August 27, 1945, two adult males were caught in a meadow under a dense clump of St. John's wort (*Hypericum densiflorum* Pursh). The ground was dry, although small struggling patches of sphagnum were found within about 20 feet of the clump. Beneath the woody bushes a network of small trails meandered. In some places fallen trash appeared to have been cut instead of being brushed aside to expedite travel, something I never have seen in a typical meadow mouse run.

Oehler (1942), writing of this lemming in Ohio, reports it as less inclined to keep to definite runways than *Microtus* and that it is often caught in traps set at random where there was no "sign." Preble (1942), also writing of this lemming in Ohio, reports seeing them running back and forth in runways at all hours of the day. He found them in grassy areas associated with *Blarina* and *Microtus*. *Blarina* was the only other small mammal found near the Mountain Lake lemming station.

On August 28, 1945, a young male lemming was caught about 100 yards east of the other location. The immediate surroundings were essentially dry, the vegetation being primarily grasses and goldenrod. As in the first place a network of trails suggested a more generous population earlier in the year. Several other locations with abundant trails yielded only one or two shrews (*Blarina*) when near alder bushes and none where more open.

The oldest lemming record for southwestern Virginia with which I am acquainted is for a specimen taken January 13, 1911, by Dr. Ellison A. Smyth, Jr., under an old corn shock in his garden on the lower V.P.I. campus at Blacksburg, 18 miles south of Mountain Lake and about 2,100 feet above sea level. Grassy meadows were adjacent to the garden, no woods were nearby, and no sphagnum occurred anywhere in the neighborhood.

Hooper and Cady (1941) report five specimens of this lemming from three points in southwestern Virginia, namely, Cleveland (1,700 ft.) in Russell County, Sugar Grove (3,000 ft.) and a point on Walker Mountain (3,800 ft.), both in Smyth County. Stewart (1943) reports a female taken October 24, 1941, in the Shenandoah Mountains of Augusta County. Across the state line in eastern Kentucky, Welter and Sollberger (1939) record the taking of two lemmings.

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THOMAS SMYTH, *State Teachers College, Indiana, Pennsylvania.*

ANOTHER RECORD OF THE RED BAT IN ARIZONA

Further knowledge of the distribution of the red bat, *Lasiurus borealis teliotis*, in Arizona is provided by a specimen I examined recently in the Strecker Collections at Baylor University, Waco, Texas. This bat, a male, was taken September 8, 1900, at Phoenix, Maricopa County, by George F. Breninger.

This record coupled with those already in the literature establishes the red bat as a regular, but uncommon summer visitor (June to September) in Arizona.—WILLIAM B. DAVIS, *Department of Fish and Game, Agricultural and Mechanical College of Texas, College Station, Texas.*

IDENTITY OF THE TYPE OF PEROMYSCUS SAGAX ELLIOT

Examination of the type specimen of *Peromyscus sagax* Elliot (Field Columb. Mus., publ. 71, zool. ser., vol. 3, p. 142, Feb., 1903) from La Palma (not Pátzcuaro, as frequently recorded), Michoacán, Mexico, reveals that it is not a member of the *Peromyscus truei* group, and thus not a synonym of *Peromyscus truei gratus*, as suggested by Osgood (North Amer. Fauna, no. 28, p. 173, 1909). *P. sagax* proves to be a member of the *Peromyscus boylii* group, and evidently is conspecific with *P. boylii*. Dr. W. H. Osgood has confirmed this identification. Osgood (*op. cit.*) records *Peromyscus boylii evides* from Los Reyes, Michoacán, 43 miles to the south-southeast of La Palma, and *P. b. levipes* from Pátzcuaro, Michoacán, and Ocotlán, Jalisco, 90½ miles southeast of La Palma, and 14½ miles north of La Palma, respectively. The specimen from La Palma is immature, and consequently it is difficult to allocate it to one subspecies or the other. Comparison of the type of *sagax* with a limited number of specimens, of comparable age, of *levipes* from central Mexico reveals that *sagax* is practically indistinguishable from the latter race. Tentatively, *sagax* may be regarded as a synonym of *Peromyscus boylii levipes*. When adult specimens from La Palma are available for comparison, they may prove to be referable to the subspecies *evides* (Osgood, Proc. Biol. Soc. Washington, vol. 17, p. 64, Mar. 21, 1904). In that event, according to the law of priority, the animals currently designated as *P. b. evides* would take the name *Peromyscus boylii sagax*.—DONALD F. HOFFMEISTER, *Museum of Natural History, University of Kansas.*

TWENTY-SIXTH ANNUAL MEETING OF THE AMERICAN SOCIETY OF MAMMALOGISTS

The twenty-sixth annual meeting of the American Society of Mammalogists was held at the Carnegie Museum, Pittsburgh, Pennsylvania, April 17-20, 1946. Approximately 125 members and guests attended, including several from Canada and Latin American countries.

PROGRAM

WEDNESDAY, APRIL 17

6:30 *p.m.*

Annual Banquet

American Society of Ichthyologists and Herpetologists

Address by Karl P. Schmidt, President:

The new systematics, the new anatomy and the new natural history.

9:30 *p.m.*

Meeting of the Board of Directors, Hotel Webster Hall

THURSDAY, APRIL 18

9:00 *a.m.*

Exhibition of flash light photographs of mammals by William P. Harris, Jr., University of Michigan.

10:00 *a.m.*

1. Address of Welcome. O. E. Jennings, Acting Director, Carnegie Museum.
2. Response of President, E. Raymond Hall.
3. A study of the baculum in the microtines. William J. Hamilton, Jr., Cornell University. Slides.
4. Molt and primeness in mammals. Seth B. Benson, University of California. Slides.
5. The phylogeny of the dipodoid rodents of North America. Donald F. Hoffmeister, University of Kansas. Slides.
6. Courting reactions and copulation of the porcupine, *Erethizon d. dorsatum*. Albert R. Shadle, M. Smelzer, and M. Metz, University of Buffalo. Slides.

2:00 *p.m.*

(Joint session with American Society of Ichthyologists and Herpetologists.)

7. A punch-card method for organizing specimen and bibliographic data. Arnold B. Grobman, University of Rochester.
8. Effects of aircraft-distributed DDT oil sprays upon populations of cold-blooded vertebrates. Capt. Earl S. Herald, AAF Committee on Aerial Dispersal of Insecticides, AAF Proving Ground Command, Orlando, Florida.
9. The Pan-American convention on nature protection in the Western Hemisphere. Harold J. Coolidge, Jr., Museum of Comparative Zoology.
10. Reptiles and amphibians in the region of the new Mexican volcano, Parícutin. Norman Hartweg, University of Michigan. Slides.
11. Effect of recent vulcanism on the mammal fauna of Parícutin, Mexico. William H. Burt, University of Michigan.
12. Artesian springs and their relationships to animal life. Claude W. Hibbard, University of Kansas. Slides.
13. The condition of vertebrate collections in Japan. J. Linsley Gressitt, St. Louis, Missouri.
14. Biotic zones and provinces as distributional concepts. E. A. Goldman, U. S. Fish and Wildlife Service.

15. Zoological subspecies of man at the peace table. E. Raymond Hall, University of Kansas. Slides.
16. Development of a shark repellent. Committee on Medical Research and the U. S. Navy. Harold J. Coolidge. Museum of Comparative Zoology. Motion pictures in color.

8:00 *p.m.*

The American Society of Mammalogists and American Society of Ichthyologists and Herpetologists were guests of the Pittsburgh Zoological Society at a Smoker in the Pittsburgh Athletic Association.

FRIDAY, APRIL 19

9:00 *a.m.*

Annual Business Meeting of the Society; election of officers.

10:45 *a.m.*

17. The 1945 Carnegie Museum expedition to Hudson Bay. J. Kenneth Doutt, Carnegie Museum. Motion pictures in color.

2:00 *p.m.*

18. A comparative study of the breeding season of rats in Texas and Maryland. David E. Davis and John T. Emlen, School of Hygiene and Public Health, Johns Hopkins University. Slides.
19. Sex ratio and weights of southwestern Lake Erie muskrats. John M. Anderson, Winous Point Waterfowl Club, Port Clinton, Ohio.
20. Origin of animals moving into a continuously trapped area. Lucille F. Stickel, U. S. Fish and Wildlife Service. Slides.
21. A study of rodent populations on Guam, Mariana Islands. Rollin H. Baker, U.S.N.R. Slides.
22. Progress in behavior and ecology of *Neofiber*. J. Eric Hill, American Museum of Natural History. Slides.
23. Some oddities in coyote denning. Stanley P. Young, U. S. Fish and Wildlife Service. Slides.
24. Wolf *versus* sheep in Mount McKinley National Park. Victor H. Cahalane, U. S. National Park Service. Slides.
25. Formation of mounds in western Washington. Arthur Svihla, University of Washington. Slides.
26. The gestation period of the porcupine *Erethizon d. dorsatum*. Albert R. Shadle, University of Buffalo.
27. Tree-top acrobats (white-handed gibbons). Lee S. Crandall, New York Zoological Society. Motion pictures in color.

7:00 *p.m.*

Annual Banquet—Carnegie Institute Cafeteria

Cleveland P. Grant with kodachrome motion pictures, entitled "Rams of the Rimrocks."

SATURDAY, APRIL 20

9:00 *a.m.*

28. Notes on the behavior of various Alaskan mammals. Charles G. Wilber, Fordham University. (Read by title only.)
29. Big-game estimate problems. Hartley H. T. Jackson, U. S. Fish and Wildlife Service.
30. Photographing mammals. Ernest P. Walker, National Zoological Park.
31. The Wilderness Society. Howard Zahniser, Wilderness Society.
32. Notes on some Maine Shrews. Ralph S. Palmer, Vassar College. Slides.
33. Latex in the field of natural history. Ottmar F. von Fuehrer, Carnegie Museum.

10:30 *a.m.*

Final Business Meeting

1:30 *p.m.*

Members assembled at the Lecture Hall entrance to elect guides for a trip to the Pittsburth Zoological Gardens, the Buhl Planetarium, or the Phipps Conservatory and the University of Pittsburgh.

At the meeting of the Board of Directors on April 17, positions were filled as follows: William K. Gregory, trustee for the term 1946–1949, Remington Kellogg, representative to the National Research Council for the term 1946–1949, and William B. Davis, Chairman of the Editorial Board for the year 1946.

At the annual business meetings on April 19 and 20, the following officers were elected: Edward A. Goldman, President; Rudolf M. Anderson and Reminington Kellogg, Vice-presidents; Seth B. Benson, Recording Secretary; Emmet T. Hooper, Corresponding Secretary; Viola S. Schantz, Treasurer. Directors elected for the term 1946–1948—Victor H. Cahalane, E. C. Cross, William J. Hamilton, Jr., John Eric Hill, and Adolph Murie. Because there was no election of officers in 1945, directors for the term 1945–1947, to take office as of 1945—William H. Burt, Harold J. Coolidge, Jr., J. Kenneth Doutt, Claude W. Hibbard, and G. H. H. Tate.

The Index Committee reported that volumes 21–26 (1940–1945) of the Journal of Mammalogy were being indexed and that subsequent volumes will be indexed as published. Copy for the index for volumes 21–30 will, therefore, be ready for publication soon after volume 30 is published.

It was decided to meet jointly with the American Society of Ichthyologists and Herpetologists in 1947 at a place and time to be determined later. In 1948 the Society will be guests of the Royal Ontario Museum, Toronto, Canada.

The Society learned with regret of the death of twelve members, two of whom (*) were charter members: Edward H. Bean, Sept. 5, 1945; H. O. Borgfeld, Jr., killed in action, January 29, 1945; Ralph Ellis, III, December 17, 1945; W. Carl Gower, killed in action February 5, 1945; Curtis J. Hesse, May 8, 1945; H. Horring, 1943; L. J. Palmer, June 20, 1945; Ronald Ward Smith, killed in action, September 11, 1944; Irwin Spalding, May, 1944; *M. H. Spaulding, 1945; *Francis B. Sumner, September 6, 1945; George Willett, August 2, 1945.

The Corresponding Secretary presented a summary of memberships, and subscription to the Journal of Mammalogy, as follows:

Memberships	*1944*		*1945*	
Change since preceding annual report				
Nominees		51		82
Resignations	8		7	
Deaths reported	10		12	
Members dropped (delinquent)	55		27	
Total decrease		73		46
Net change		−22		+36
Status as of December 31				
Honorary members (1 also Life)	3		3	
Life members	48		49	
Members inactive for duration	68		65	
Annual members (excluding above inactive members)	764		802	
Total membership		883		919
Corrected total (one member both Life and Honorary		882		918

	1944		1943	
MEMBERSHIPS				
SUBSCRIPTIONS				
Change since preceding report				
New subscriptions	23		23	
Subscriptions cancelled	18		11	
Net change		+5		+12
Status as of December 31				
Total paid subscriptions		225		237
MAILING LIST				
Total membership	882		918	
Members not receiving Journal	138		116	
Total members receiving Journal (inactive and delinquents)		744		802
Total paid subscriptions		225		237
Total mailing list		969		1,039
Net change from preceding year		+9		+70

Reports of standing committees and of representatives to other societies were presented and placed on file.

In recognition of an activity of the American Committee for International Wildlife Protection the Society went on record as follows: The American Society of Mammalogists congratulates the American Committee for International Wildlife Protection on the conception and execution of its two-volume publication on the subject of Extinct and Vanishing Mammals of the Old World and the Western Hemisphere. It takes pride in the fact that the authors, Francis Harper and the late Glover M. Allen, and the Society's representatives, Harold J. Coolidge, Jr., and W. R. Blair, have been honored members of the Society for many years.

The following resolutions were read and unanimously adopted:

Whereas the Carnegie Museum, the Pittsburgh Zoological Society, and the Chairman and members of the local committee, particularly Mr. Lawrence C. Woods, Jr., have provided facilities and entertainment which have contributed greatly to the success of the twenty-sixth stated meeting of the American Society of Mammalogists and the enjoyment of the attending members,

Therefore be it resolved that the Society extends to the Carnegie Museum, the Pittsburgh Zoological Society and the local committee an expression of its thanks and hearty appreciation.

Whereas Dr. William King Gregory has attained his 70th birthday,

Therefore be it resolved that the membership of the American Society of Mammalogists extends its felicitations to Dr. Gregory and its appreciation for many years of service to the Society as a trustee and member of the board of directors.

Whereas The American Society of Mammalogists has been requested to indorse the formation of an organization of biologists on the basis of the two following general propositions:

1. To provide a means for executing our public responsibilities as biologists and

scientists, so that the freedom essential to the progress of science and public welfare be ensured.

2. To safeguard the professional interests of biologists and to assist in providing the material means for the promotion of biological research; also to provide such services as may be necessary to facilitate this program,

Be it resolved that The American Society of Mammalogists goes on record as being favorable to the aforementioned objectives and to the creation of an Institute of Biology under the guidance of a council containing an adequate representation of the biological sciences.

Whereas the National Science Foundation Bill (S. 1850) for the governmental support of basic science has been reported out favorably by the Military Affairs Committee, but as yet has not been acted on by the U. S. Senate, and

Whereas this Society considers that this vitally important legislation should be enacted promptly into law, therefore,

Be it resolved by the American Society of Mammalogists that legislative action be taken immediately to obtain Senate approval for S. 1850, and that copies of this resolution be forwarded to Senator E. D.-Thomas, Chairman, Military Affairs Committee, U. S. Senate, Washington, D. C.

Recommendation: The members of this Society are requested to urge their Senators to support S. 1850.

Resolved that the American Society of Mammalogists urges the American Committee for International Wild Life Protection to bring the matter of International Nature Protection and especially the protection of threatened and vanishing species to the attention of the United Nations Organization with the hope that they will take steps to establish a Convention on Nature Protection and Wild Life Preservation that will include all the United Nations.

Whereas The American Society of Mammalogists is vitally interested in proper administration of wildlife resources and is well aware of the serious decrease in numbers of the Dall mountain sheep in the Mt. McKinley region of Alaska and

Whereas the best information available indicates that the decline in numbers is the result of a combination of factors, including diseases, and

Whereas the government agencies responsible for maintainance, protection, and study of the Dall mountain sheep are actively working on the problem, and

Whereas there is no evidence that the decline in the Dall mountain sheep population has been brought about primarily by wolves or that a general campaign of extermination of wolves in the Mt. McKinley National Park would save the Dall mountain sheep, and

Whereas it is the obligation and duty of the National Park Service to maintain all kinds of animal and plant life without discrimination, and

Whereas the National Park Service already has the legal authority to reduce the number of wolves in the Park and is now taking appropriate action to encourage recovery of the sheep population, and

Whereas the American Society of Mammalogists believes that Bills pending in Congress, H. R. 5401 and S. 1999 are unnecessary and ill-advised in focusing attention on the wolves which may not be a critical factor in the present status of the sheep,

Therefore it is the considered opinion of the Society that H. R. 5401 and S. 1999 should not be enacted into law.

Whereas the few remaining representative areas of the American wilderness are of value not only as a heritage of the past and as unique recreational areas but also as the scenes of research and as locations for check areas in connection with scientific investigations involving comparisons of conditions on natural areas with those on farms, range lands, and other areas under management, and

Whereas as the encroachments of civilization have continued, science has found the few remaining natural areas of ever-increasing value, as specifically illustrated by the current pressing need of the science of wildlife management for check-areas against which the trends of artificialized game-producing lands can be measured, and

Whereas the preservation of such remnants of the American wilderness with its primitive fauna is threatened by the development of roads, landing fields for airplanes, and other features of a highly mechanized civilization,

Therefore, Be It Resolved that the American Society of Mammalogists endorses the national movement for wilderness preservation and commends those organizations that are actively representing this movement before the public, and

Be it further resolved that copies of this resolution be presented to the Secretary of the Interior, the Secretary of Agriculture, and the Heads of the National Park Service, the Forest Service and the Fish and Wildlife Service, with the Society's recommendation that these land administering agencies vigilantly guard such wilderness areas against all invasions that would destroy or impair their primitive character.

Whereas a drastic reduction of sea lions on the California coast has been ordered by the California Fish and Game Commission, and

Whereas the case against the sea lion is based on the general prejudice of one special commercial group and not on scientific evidence, and

Whereas the California Academy of Sciences has offered to conduct an investigation of the food habits of the two species of sea lions affected, now therefore,

Be it resolved that the American Society of Mammalogists urge the California Fish and Game Commission to suspend action against the sea lions until completion of a thorough investigation of the food habits and a survey of the actual damage done to fishing gear and other property, and, furthermore,

Be it resolved that the thanks of the American Society of Mammalogists be extended to the California Academy of Sciences for its stand against the unrestricted killing of the sea lion herds and for its offer to conduct a study of the food habits of the animals.

REVIEWS

Barbour, Thomas. A NATURALIST'S SCRAPBOOK. Pp. x + 218, illus. Harvard University Press. Price $3.00.

To anyone interested in looking behind the scenes on an accomplished naturalist, this collection of essays by the late "T. B." provides not only entertaining reading but also considerable food for thought.

Boston and the nearby towns of Cambridge and Salem have long been established museum centers, with their Boston Museum of Natural History, Museum of Comparative Zoology, and Peabody Museum, among others. It is to these institutions, (their development, interesting personnel, and outstanding rarities) that much of the book is devoted. One learns, for example, the tragic history of the collections in the old Peale Museum which contained many priceless type specimens; of the vicissitudes of the famous Wilson collection of birds; of recent efforts to revitalize museums, and trends in modern museums. The chapter "Thinking Out Loud" should be an inspiration to anyone charged with directing the activities of a museum.

The travelogs are largely reminiscential, but they help one to become better acquainted with the author; to follow the vagaries of his mind; and to share in the enjoyment his numerous voyages afar brought him.

In lieu of a biography, the present book comes close to depicting the man Thomas Barbour.—W. B. DAVIS.

Best, Elsdon. FOREST LORE OF THE MAORI. Dominion Museum, Wellington, New Zealand, Bull. no. 14, 503 pp., 31 figs. 1942.

Ethnological reports seldom contain enough factual natural history to satisfy working naturalists. The present book, being one of a series of fourteen volumes devoted to special phases of Maori life, is an exception in that it contains an unusual concentration of data relating to some of the indigenous plants, birds, and mammals of New Zealand. The author died in 1931, leaving the manuscript, which, as is stated in the editor's preface, was written from time to time over a long period and "was an amalgamation of material gathered during many years in various parts of the North Island." Because of the violent faunal changes that followed the European occupation of New Zealand, our knowledge of the habits and distribution of the few and quickly decimated native vertebrate species must spring largely from aboriginal accounts. These, of course, are highly colored by tradition, and only an experienced student of Maori lore could properly evaluate them.

The book opens with an account of the uses and the methods of obtaining various plant products. This is followed by a section on bird lore, which occupies nearly 300 pages and makes up the bulk of the book. Here ornithologists will find fascinating accounts of habits, folk beliefs, and ingenious snaring devices. The birds treated at greatest length are kiwis and other ground birds, parrots, wood pigeons, and parson birds.

The 40-page account of the Maori rat or "kiore" is of particular interest to mammalogists. The history and habits of this rat have been badly obscured in technical literature through confusion with recently introduced European rats. The current belief that it is identical with *Rattus exulans* of Samoa, whence it was introduced into New Zealand in the Polynesian migrations of only a few centuries ago, is corroborated by Maori tradition. One interesting version of the immigration has the rats swimming across the open ocean in single file, each holding with its teeth to the tail of the rat in front. The Maori recognized gray and brown color phases of the kiore, but considered that both were the same kind of animal in contrast to the European rats, which they described as "detestable creatures, mischievous thieves, house-gnawers, garment-destroyers, with an abominable habit of defecating on articles of food, absolutely disgusting creatures." The native rats played an important role in Maori economy, providing a staple food supply in the absence of other land mammals. Large numbers were trapped, cooked, and potted in their own grease for future consumption. The excellent descriptions and illustrations of Maori rat traps will interest mammal collectors. The usual trap consists of a looped cord passed between two firmly anchored parallel sticks and attached to a bent-stick spring, which is released by a treadle or by tugging at the bait. In a clever portable variation, the rat releases the spring by gnawing through a thread barring access to the bait. Deep pit-traps were also commonly used. Bats were likewise eaten, large colonies sometimes being smoked out of hollow roosting trees.

By way of criticism it might be said that the style is rambling and disconnected, but then the subject does not lend itself readily to systematization. The old and subsequently corrected error of using *morio* instead of *tuberculatus* as the specific name of the New Zealand *Chalinolobus* is repeated, and the name *Mystacops* is misspelled. The obsolete nomenclature, as far as mammals are concerned, reflects the early date at which the manuscript was written and the editor's expressed desire to avoid tampering with it. The latter factor may also be responsible, fortunately, for the retention of many items of detail of the sort that an author tends to delete or obscure by generalities in final revisions of a manuscript.—DAVID H. JOHNSON.

Romer, Alfred Sherwood. VERTEBRATE PALEONTOLOGY. University of Chicago. Second Edition. Pp. +687, 377 pls., 4 tables. 1945. Price $7.50.

A standard text and reference work unique in its field, this long-familiar standby needs no introduction. Designed to place the fundamental facts and concepts of vertebrate paleontology within the reach of advanced students of vertebrate zoology, it avoids the monotony of diagnosis and description in order to present the story behind these isolated bits of knowledge. Concepts that are gained through intimate knowledge and that would otherwise be known only to specialists are explained for the benefit of all. The fundamental

importance of Dr. Romer's contribution to the integration of paleontological and neontological knowledge cannot be overemphasized.

In the telling of the story a carefully chosen path is trod between the extremes of oversimplification and of too much detail. Not only can novices explore the vastness and significance of prehistoric change in animal life, but the professional man will find much to refresh his memory, to stimulate his ingenuity, to furnish new food for thought.

No hide-bound recitation is this introduction to a field of science many zoologists think has been picked clean, ready for the museum. Romer's book is dynamic and challenging. Great effort has been spent to eliminate bias even upon the most commonly-held ideas in paleontology, with the result that the book is distinctly iconoclastic and thereby will reap the curses of those who prefer old concepts regardless of their worthiness. For his fearless analysis of the data for what they are actually worth the author deserves the highest praise. Few items if any seem to have escaped a critical re-appraisal upon the basis of what is known today—not upon what was known several years ago.

It is gratifying to observe that in compiling a work of such extensive scope, the author has, as he should, not relied exclusively upon his own knowledge, but has leaned heavily here and there upon the shoulders of numerous colleagues whose detailed knowledge in special fields has contributed materially to the authenticity and permanence of value of the book.

Many changes have been made from the first edition published 12 years previously (1933). Some chapters (as for instance that on amphibians) are so completely rearranged that they might well have been written in another century by a different man. A number of new chapters have been introduced, for the placoderms and a number of groups of reptiles; and of great importance are three new final chapters on vertebrate history, in which the whole geological history of vertebrates is admirably summarized. The work ends as does the first edition, with a very useful synoptic classification of all vertebrates to family, and of fossil vertebrates to genus. A remarkable advance over the first edition in knowledge, crystallization of concept and detachment of viewpoint is indicated not only for the field but for the author.

There is but little utility in comment upon specific details. Each critic will have his own opinion upon controversial matters, and only by general consideration can agreement be achieved. It may be said, however, that the allocation of *Seymouria* with amphibians is a surprising and stimulating departure from previous concepts and is likely to meet considerable criticism; so also is the abandonment of the Phyllospondyli as a natural grouping; the retention of the snake families Boidae and Pythonidae, with unquestioned allocation of all fossil "boid" genera to one family or the other; and no doubt many others. Herpetologists can welcome the simplification of lacertilian classification and the retention of crocodilian nomenclature despite Mertens' arguments for a general nomenclatorial shift.

It may be regretted at times that the source of information is not given for statements which would appear to deserve further investigation, or which result from recent investigation; and that there is a lack of conformity in the sequence of vertebrate groups in the discussion and in the classification. The lack of conformity, which sometimes extends to downright contradiction (p. 155, order Salientia, superorder Anura; p. 591, superorder Salientia, order Anura) contributes to the reader's skepticism of the often novel phylogenetic arrangement. No indication is given for the basis for the extraordinary arrangement of literature references, which, for each major group, are given in neither alphabetical nor chronological order, but apparently in order of importance; known references accordingly cannot always be found readily, although the system has its obvious advantages. The reader is, furthermore, left to assume that bracketed names in the section on Classification are synonyms. But few typographical errors (Wolterstorfiella not Walterstorfiella) have come to attention. The format is admirable.

Whatever criticisms may be levelled, the fact still remains that the new edition of Vertebrate Paleontology is a work that, directly or indirectly, exerts an influence upon and must

be reckoned with by every serious student of vertebrate zoology. For a worthy contribution toward the advance of scientific knowledge Alfred Sherwood Romer and the University of Chicago press deserve a high place in the annals of modern zoology.—HOBART M. SMITH.

Simpson, George Gaylord. THE PRINCIPLES OF CLASSIFICATION AND A CLASSIFICATION OF MAMMALS. Bull. Amer. Mus. Nat. Hist., vol. 85, pp. xvi + 350, October 5, 1945.

The classification recognizes 32 orders (14 or 44 per cent extinct), 257 families (139 or 54 per cent extinct), and 2864 genera (1932 or 67 per cent extinct). The genus is the smallest taxonomic category included except that subgenera are noted in a few groups. As a rule only names regarded by the author as valid are listed. That is to say, synonyms mostly are omitted.

Between phylum and class, Simpson employs subphylum and superclass; between class and order, he employs subclass, infraclass, cohort and superorder; between order and family there are suborder, infraorder and superfamily; between family and genus, there are subfamily, tribe and subtribe. The use of cohorts is unusual in recent classifications and serves to emphasize similarities between superorders.

In the formal classification itself some of the most "interesting reading" is in the footnotes. From these it is learned that *Speothos* antedates *Icticyon* as the generic name of the brush dog. For an extinct genus of peccary, *Tavcanamo* is proposed to replace *Choerotherium* Lartet (*nec Choerotherium* Cautley and Falconer). *Alce* Frisch, 1775, antedates *Alces* Gray, 1821, as the name of the moose. Names now in use that probably are synonyms are mentioned.

In a terminal section, Simpson makes clear his reasons for associating the carnivores and ungulates in a single cohort and explains why the tupaioids (tree shrews) are placed in the Primates instead of in the Insectivora. Frick's much criticized classification of the Cervoidea is defended (p. 267) and an interpretation (p. 247) of Osborn's classification of the Proboscidea is given. The interpretation could profitably be read as a preface by every systematist who uses Osborn's monograph.

The effective use which Simpson makes of the linear hierarchy of the Linnean classification, in part results from his strict adherance to the "International Rules of Zoological Nomenclature," including, of course, the Law of Priority. Because the reviewer regards it as logical to extend this law even to position of names within a single line of print, it is surprising to find Simpson (p. 154) maintaining that it "would be absurd to prefer †*Paraceros* [over *Antifer*] because of page or line priority."

For a person whose writings mostly relate to paleontology ("Paleozoologist") Simpson has a remarkably accurate understanding of the viewpoint of the person whose writings mostly relate to living animals ("Neozoologist"). Neozoologists will be interested in Simpson's view that the student of species and subspecies, using the Linnean classification to explain differences and resemblances, and in correlating these differences and resemblances with known factors of evolution, are carrying on a revolution which will require another two centuries or so of profitable work. Study of phylogeny and the reconstruction of classification in accordance with it, he points out, involves both neozoology and paleozoology.

In commenting on taxonomy and nomenclature Simpson writes "Simply distinguishing between things belongs on a low level of intellectual pursuits and degenerates into hackwork. It was no coincidence that this extreme splitting phase coincided with the growing disrepute of taxonomy and a strong movement away from this division of biology toward others, particularly experimental and ecological studies. These studies are now being redirected into the field of taxonomy where they will assist in achieving a better balance between analysis and synthesis.

"Many biologists and even some taxonomists seem to feel rather pride than shame in their ignorance of the principles of zoological nomenclature. The same men would be quick to condemn a solecism in the use of their native languages, and nomenclature is the grammar and vocabulary of zoology. Neither nomenclature or grammar is an end in itself, but they

are not less important on that account. The comparison can be extended to point out that literate men do make mistakes in grammar and literate zoologists do make mistakes in nomenclature, but that only dolts see in this an excuse for illiteracy."

Simpson's classification may be expected markedly to affect mammalogy in that collections that are rearranged will follow his classification, continental and stratigraphic lists of mammals will be influenced by it, and the new crop of mammalogists will adopt at least its broad features as the starting point for their studies of selected groups. It is both fortunate and fitting that a classification po entially so influential was prepared by the person at present probably better qualified than any other to do so.—E. RAYMOND HALL.

Hall, E. Raymond. MAMMALS OF NEVADA. University of California Press, pp. xi + 710, 485 figs., 11 pls., 1946. Price $7.50.

As indicated by the title, this book treats all the kinds of living mammals of Nevada. Ground work for it was laid more than 35 years ago by personnel from the University of California and in the intervening years numerous individuals assisted in the field in accumulating information. In preparation of the accounts the author had available nearly 18,000 specimens of Nevada mammals as well as hundreds of pages of manuscript field notes.

The book is divided into 25 sections, chief of which is the *Accounts of Species and Subspecies* (532 pages). Introductory sections treat the topography of Nevada, climate, floral belts, life-zones, faunal areas, factors responsible for geographic distribution and speciation, check list, and an illustrated key to the species. The work is concluded with an account of the 68 type localities of mammals in Nevada, a gazetteer of localities, a glossary, a bibliography, and an index.

For each of the 232 kinds of Nevada mammals, belonging to 111 species, are given (1) currently accepted scientific name, (2) vernacular name, (3) synonymy, including citation to the original description, (4) known distribution in Nevada, (5) measurements, weights, systematic comments, and natural history notes when available, and (6) specific records of occurrence in Nevada by county and precise locality. Distribution maps and drawings of skulls are provided for most species.

The obvious emphasis placed on systematics and geographic distribution in the accounts of species reflects the major interests of the author and at the same time points out the chief weakness of the book, namely, the general lack of information on life history. Whenever available, however, this information is given. It would seem desirable for all future field work in mammalogy to be so planned that at least part of the time is devoted regularly to gathering life-history and ecological data. Even the simplest facts about many species of mammals are not known, largely because the collecting of large series of museum specimens has been emphasized.

Of interest is the author's treatment of mammal distribution in Nevada from both the life-zone and the faunal area points of view, accompanied in the latter instance by a further multiplication of terms and concepts to badger the student of biogeography. Seemingly no attempt was made to identify the faunal areas of Nevada with those in adjacent states. For example, the Central Rocky Mountain Faunal Area Hall sets up for northern Nevada is synonymous with the Northern Great Basin Biotic Area recognized by Davis (The Recent Mammals of Idaho, 1939) in southern Idaho, and Hall's Northern Great Basin Faunal Area is something entirely different. Standardization of terms and concepts would help materially to avoid such needless confusion.

The book is well executed for the most part. It probably will find its chief usefulness among students of Mammalogy and game management, but will likely have little appeal to persons lacking some technical training in the field of mammalogy. It constitutes the basis for any future mammalogical investigations in the Great Basin area. Both the author and the publisher merit commendation for a job well done.—W. B. DAVIS.

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(Conducted by Gerrit S. Miller, Jr., Remington Kellogg, and Emma M. Charters)

[Reprints of this section may be purchased from the Corresponding Secretary]

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COMMENT AND NEWS

GROUP PICTURE AVAILABLE

The group picture taken at the Annual Meeting at Pittsbursh is still available to those who missed getting one. Send your dollar to Kenneth Doutt at the Carnegie Museum.

VITAL STATISTICS

Members are requested to notify the Corresponding Secretary of the death of any member of the Society. The following information is desirable for the Society's files: Full name of the deceased, date and place of death, date and place of birth, name of father and mother, names of next of kin.

THE MAMMAL ROOM, BRITISH MUSEUM (NATURAL HISTORY)

Mammalogists may like to have some news of how the Mammal Room has fared during the recent contest and of the present position.

At the time of 'Munich' a pessimistic view was quite rightly held and the evacuation of the type specimens to less vulnerable quarters had begun, but the optimism and wishful

thinking which followed on the meeting of September 29, 1938, called a halt. Evacuation was resumed on the outbreak of war and in spite of difficulties due to lack of transport and material and shortage of staff, many of whom had military commitments, the process continued steadily and all the types and the bulk of the other specimens were soon distributed in places of relative safety in many parts of the country. The only damage so far apparent is that the labels on the outsides of the spirit jars became illegible due to the mould which they acquired in the damp atmosphere of a cave. However, the labels inside the jars were all right and the only evil result has been a considerable waste of time in writing new exterior labels.

The staff is now about half what it was. M. A. C. Hinton had left the Mammal Room in 1936 already to become the Keeper of the Department of Zoology and during the war a further loss was sustained by the death of Captain J. G. Dollman. The team now consists of T. C. S. Morrison-Scott as Assistant Keeper in charge of mammals and R. W. Hayman and G. C. W. Holt as Technical Assistants whose sterling quality hardly makes up for lack of quantity. J. King, the junior member of the staff, is still in the Army serving as a captain.

The Mammal Room is lucky in its voluntary workers. R. I. Pocock is at work on his Catalogue of the Carnivora and also on his third volume of the Fauna of British India. J. L. Chaworth-Musters is busy with his Checklist of Palaearctic Mammals and Sir John Ellerman is completing the third volume of his Families and Genera of Living Rodents. Apart from their own work these three gentlemen are generous in their help with the Museum business.

So far it has not been possible to bring back to London much of our material. This is because incendiaries burnt out the wing of the Museum occupied by the botanists and under a scheme for the reallocation of space it has been decided that they should be rehoused in the wing formerly used by the Mammal Room. As many mammalogists know, it was the intention, prior to the contretemps with the Herrenvolk, to move the Mammal Room to Tring, to the Zoological Museum which was left to the nation by the late Lord Rothschild. That scheme has now been knocked in the head due to one thing and another and the mammals are to occupy the Old Spirit Building of the B. M. (N. H.) in London. This is, as its name implies, an old building and stands at the back of the main structure. Before the war it was scheduled for demolition. However, the needs for the rehousing of the population of this country are such that there is little prospect of any new construction for philosophical purposes and, small though the building is and allowing as it does no room for expansion, we shall have to make do. Before the specimens can be brought back to London various works have to be completed in the Old Spirit Building to make it suitable. These are unlikely to be completed this year.—T. C. S. Morrison-Scott.

STAGER RETURNS TO LOS ANGELES COUNTY MUSEUM

Captain Keneth Stager, Inf. AUS., has returned recently to his position as Assistant Mammalogist in the Los Angeles County Museum, Los Angeles, California. During the war, Capt. Stager served as infantry officer assigned to the Chinese Army in the North Burma Campaign, as commanding officer of the heavy weapon's company, 1st Battalion, 475th Infantry, Mars Task Force in the Central Burma Campaign, and subsequently, as mammalogist and ornithologist for the Burma-India field party of the U.S.A. Typhus Commission on scrub typhus research in the CBI Theater. After returning to the UnitedStates in late 1945, Capt. Stager was detailed to the U. S. National Museum to prepare reports on his collected specimens of birds and mammals.

Capt. Stager's change from front-line fighting to research was sudden and dramatic. He was called out of his fox-hole by field radio at the suggestion of the chief surgeon of the nearby base hospital on the arrival of Col. Mackie, chief of the typhus work in the CBI Theater, and was soon wielding mouse-trap, scalpel and tweezers, instead of heavy weapons.

BAKER RETURNS FROM PACIFIC

Lieutenant Rollin H. Baker, H(S), USNR, is now assigned on temporary duty to prepare reports in the divisions of Birds and Mammals, U. S. National Museum, Washington, D. C. Lieut. Baker, after a year as deck officer on a destroyer on convoy duty in the Atlantic and western Mediterranean, was transferred to the Naval Medical Research Unit. No. 2, headquarters Guam. During the course of his new duties, he collected vertebrates, principally birds and mammals, in the Mariana, Carolina and Palau islands. Lieut. Baker, as a civilian before the war, was connected with the Texas Game, Fish and Oyster Commission.

HAMILTON RETURNS TO CORNELL

Major William J. Hamilton, Jr., SnC, American Military Government, has returned recently from 3½ years in the Army to his former position as Associate Professor of Zoology, Cornell University, Ithaca, N. Y. Major Hamilton was stationed in Texas, England, France, and lastly in Mannheim, Germany, doing sanitation work. His activities must have been multitudinous and interesting, but details are lacking.

JOHNSON RETURNS FROM PACIFIC

Lieutenant-Commander David H. Johnson, H(S), USNR, mammalogist of the Naval Medical Research Unit, No. 2, headquarters Guam, has returned from the Pacific, and is now on official detail at the Division of Mammals, U. S. National Museum, where he is studying his Pacific mammal collections made in the Solomon, Mariana, Philippine and RiuKiu islands. He expects to take over his regular position as Associate Curator of Mammals in the U. S. National Museum shortly after July 1, 1946.

OBITUARY NOTICES

It is with deep regret that we report the deaths of the following members of the Society.

Abbott, Clinton G., Natural History Museum, San Diego 1, California, Deceased March, 1946.

Barbour, Dr. Thomas, Museum of Comparative Zoology, Cambridge, Massachusetts. Deceased January 7, 1946.

Burns, Frank L., Berwyn, Pennsylvania. Deceased February 7, 1946.

Davis, William T., 146 Stuyvesant Place, Staten Island, New York. Deceased January 22, 1945.

Dolan, Brooke, 2nd., Villa Nova, Pennsylvania. Killed in action in China, August 19, 1945.

Hubback, Theodore R., Sunlaws, Bukit Betong, Kuala Lipis, Pahang, Federated Malay States. "Deceased" 1946.

Kashkarov, Dr. Daniel, Universitetskaja Naberejnaja, 7/9 Kv. 13, Leningrad, U.S.S.R. Deceased 1941.

Scalon, W. W., c/o Madame Sofie N. Scalon, Troudowaja No. 6, Nowosibirsk, Sibirie, U.S.S.R.